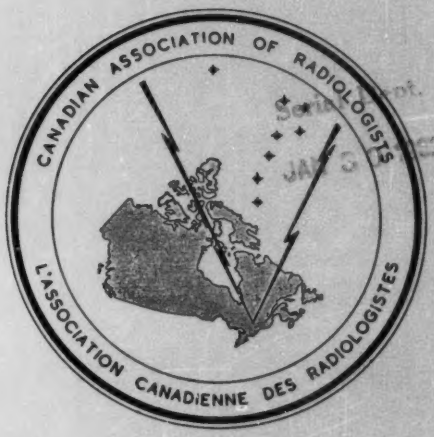
Journal of the Canadian Association of Radiologists



Journal de l'Association Canadienne des Radiologistes

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EDITORIAL

"A LITTLE PRIVACY"

There is every reason to believe that in spite of the vast expansion of hospital radiologic facilities that has occurred in the past few years, further expansion in the very near future is inevitable. The population explosion, the coast to coast institution of government-sponsored hospitalization insurance, and the imminence of medical insurance in at least some of the provinces are bound to increase the demand for diagnostic facilities. Not only the facilities, but the diagnostic skills of the radiologist are and will be increasingly required in burgeoning diagnostic departments.

Much thought has been given to hospital and radiology department planning. The modern department shows the results of this thought, being planned and equipped for maximum efficiency in handling the increasing number and complexity of examinations. There is however one consideration which may have been overlooked in planning X-ray departments. This is the matter of a little privacy and quiet for the radiologist who is trying to do thoughtful, careful work. It is accepted without question that the surgeon, the pathologist and many other specialists will not be asked to do critical work and make difficult judgements in noisy or crowded conditions. Should the same not be said of the radiologist specializing in diagnosis? In planning an X-ray department, should some thought not be given to setting aside an area, even a small area, for each radiologist to work in without undue exposure to the conversations of others?

To go back to an X-ray report and see that it is clearly in error is extremely distressing. This does and must happen to all of us at times, but it is obviously important to reduce the incidence of errors in every possible way. One can never, when recalling a mistake in radiographic recognition, diagnosis or judgement, have recourse to the excuse that there were two or three conversations going on about interesting cases, and one good story being told in the same room, when the report or the judgement was made. Yet this is actually happening every day in the practice of the specialty of Roentgen diagnosis.

One should add to the reasons for privacy, the matter of fatigue. Fatigue has been considered in planning departments of radiology, and much has been done to reduce factors which contribute to it, such as illuminator glare and colour discord, but noise and distraction also contribute to fatigue. Provision for some privacy and reduction of noise by suitable acoustic design have much to contribute to the success or otherwise of the radiologist's efforts.

A plea for a little privacy should not be construed as neglect of the great importance of accessibility of the radiologist for consultation. The diagnostic radiologist literally thrives on consultation and close liaison with his colleagues in other specialties, and we are not suggesting that he be sequestered in an office somewhere where he cannot be reached. On the contrary, we are suggesting that good engineering and good planning can reconcile the apparently opposed requirements of privacy and accessibility. Surely a place can be found for the diagnostic radiologist to do his work and still to be accessible, without being surrounded by a babble of voices. Perhaps the answer is a group of "viewing" or "reporting" rooms, one for each radiologist, immediately adjacent to a larger consultation room where crowds can gather at a moment's notice. Each radiologist should have some place, however small, where he can read, study, write, perhaps even medidate once in a while.

What is suggested, in short, is that if a physician chooses to specialize in diagnostic radiology, he may look forward to working in conditions which would be equally suitable to other specialists doing other and equally important jobs. He can be close to the production line of a large hospital, but not in the midst of its clamour; he can produce, but not without hearing himself think.

J. S. D.

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QUARTERLY

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MEASUREMENTS OF THE CALIBRE OF HUMAN BRONCHI IN THREE PHASES OF RESPIRATION BY CINEBRONCHOGRAPHY

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Changes in bronchial calibre during the respiratory cycle have long been recognized as a normal occurrence. In fact, as early as 1920 the dynamic activity of the tracheobronchial tree was recognized and described by Bullowa and Gotlieb in the experimental animal by the use of X-ray motion pictures[3]. Many of the early investigators[7,8,18,22,26] ascribed these movements to intrinsic bronchial peristalsis, an observation which has been refuted in more recent radiologic studies[9,17] and which is now held to be untenable in the light of present-day knowledge of the mechanics of respiration[4,13].

Despite the considerable literature that has developed on bronchial movements however, little information is available on the specific diameters of the bronchi during the various phases of respiration. Accurate measurements of the trachea and 1st stage bronchi of cadavers were published by Merendino and Kiriluk in 1954[23], and by Jesseph and Merendino in 1957[19], but these calibres represented resting diameters in which the bronchi were open to the atmosphere and were not under the influence of transbronchial or intrathoracic pressures. Similarly, the Handbook of Respiration[1] records mean values for the diameter of normal human bronchi, but the bronchogram of any normal adult will show the inaccuracy of these figures for any practical purpose (for example, the 2nd stage bronchus of the right lung, or intermediate stem bronchus, is recorded as having a mean value of 4.0 mm., whereas the actual diameter of this bronchus in life is over 10 mm.).

However, when one considers the rapidity with which the bronchi are capable of change in calibre, of the order of 30 milliseconds or less, it is perhaps not surprising that until recent years the limitations imposed by technical apparatus have prevented accurate bronchial measurements in phases of respiration other than maximum inspiration. The recording of changes occurring so quickly obviously requires rapid film techniques, and only in the past few years has cinefluorography been developed to a point where detail is fine enough for accurate measurement and where dosage rates have been reduced to reasonable limits of tolerance.

During the past two years, fifty-five bronchographic examinations of fifty-three patients have been carried out at the Royal Victoria Hospital using a three-stage technique only slightly modified from that described by Popper and Wolf[24]. Fluoroscopic, radiographic and cinefluorographic techniques were applied to each examination in an attempt to assess both morphological and functional changes in the tracheobronchial tree. In several patients, the cinefluorographic studies revealed considerable variation in the calibre of bronchi of the same division in response to certain phases of respiration, particularly cough and forced expiration. In an attempt to assess the magnitude of this variation, the transverse diameter of five divisions of the right lung and four of the left have been measured in maximum inspiration, quiet expiration and cough. The purpose of this paper is to record these bronchial measurements and to describe the techniques used to obtain them. In addition, the differences observed between the normal patients and those with various pulmonary diseases, notably asthma, chronic bronchitis and emphysema, will be described.

Technique of Examination

The usual premedication consists of 35 mgm. codeine subcutaneously and 100 mgm. of a fast-acting barbiturate parenterally about one hour prior to examination. Thorough topical anesthesia is obtained by application of xylocaine, 4% to the larynx and 2% to the tracheobronchial tree. The patient is positioned at 45° obliquity, with the examining table angled at 45°, and a radiopaque-tipped urethral catheter inserted transnasally into

the tracheobronchial tree with its end orifice at the distal end of the main stem bronchus of the side to be examined. The patient is then requested to hyperventilate and the total amount of 15 cc. of opaque medium (aqueous suspension of Dionosil) is injected over a period of several seconds, but during the inspiratory phase of respiration only. Almost all radicles of the bronchial tree down to Stages VI or VII are filled by this technique, but if adequate filling is not accomplished, the patient is positioned in such a manner as to aspirate opaque medium into unfilled segments. Pulmonary function studies performed on a small number of patients before and after unilateral and simultaneous bilateral bronchography have indicated moderate impairment after bronchography in the bilateral group, particularly of alveolo-capillary diffusion, so that during the past two years only unilateral injections have been made.

The equipment consists of a 16 mm. camera with synchronized exposures recording from the output phosphor of a Picker 8 inch Image Amplifier. Dupont Cineray and Kodak Linograph Shellburst cine films were used almost interchangeably, although the former appeared to give better detail and the latter more contrast with similar radiographic factors.

Cinefluorographic studies at 15 frames per second are begun after complete filling has been obtained, with the subject in the upright position in different degrees of rotation (but seldom more than 45° from the frontal plane). The movements of all major and minor bronchi are recorded during maximum inspiration and quiet expiration. When an adequate record of all divisions has been obtained, standard roentgenograms of the chest are made in postero-anterior, oblique and lateral projections in the upright position. The patient is then returned to the fluoroscopic table and cinefluorographic studies are obtained in various obliquities during violent coughing, using a camera speed of 30 frames per second. Following coughing, final roentgenograms of the chest are made in postero-anterior and oblique projections.

Dosage rates during cinefluorography alone have been found to be within a reasonable range. The X-ray beam at 100 kilovolts has a half-value layer of 4.5 mm. Al., delivering 8.5 roentgens per minute surface dose at 15 frames per second. Since the average length of cine film exposed is about 50 feet, total dosage amounts to 19 - 20 r surface dose, which is comparable to that delivered by standard non-amplified fluoroscopy for the same exposure time. Since spot films during fluoroscopy are not regarded as necessary, total dosage is less than that received during standard bronchography.

Case Material

With the exception of a number of cases of chronic bronchitis or emphysema, for whom a special request was received for information as to bronchial reaction to respiration, most patients referred for bronchography over a period of several months were examined by the cinefluorographic technique, regardless of their underlying disease.

Of fifty-five bronchograms performed, the cine studies of thirty-two have been selected as being technically adequate for bronchial measurement. Reasons for exclusion included film over-exposure or under-exposure, or lack of sufficient definition for accuracy of measurement. Ten cases of bronchiectasis have also been excluded because of severe bronchial deformity.

The average age of all patients was 43 years, the range being 13 to 63 years. Pulmonary function tests were performed in 20 of the 31 patients studied. The 31 patients* included in the study have been classified into four reasonably distinct groups (Table I), each patient fulfilling the following criteria for inclusion:

Normal: No convincing clinical or bronchographic evidence of bronchial disease in the lung being assessed.
Bronchography in these patients was requested either for complaints which eventually proved to be originating elsewhere (for example, hemoptysis, which was later found to be arising from the hypopharynx); or in cases of unilateral bronchiectasis where the contralateral lung was being investigated and showed no evidence of disease.

Bronchial Asthma: A clear-cut allergic history with spasmodic attacks of dyspnoea and wheezing occasioned by exposure to an allergen.

Chronic Bronchitis: A history of at least three years duration of chronic cough, productive of varying amounts of sputum not less than one ounce per day; the pulmonary disability did not suggest the presence of emphysema on either clinical grounds or on pulmonary function studies where available.

Emphysema: No case was included in this group without adequate confirmation of the diagnosis by pulmonary function tests on the basis of criteria previously published[2,10]. Chronic bronchitis was present in the majority of patients in this category. Table I indicates the division of patients

* *In one patient both right and left bronchial trees were studied.*

in these clinical groups into side of bronchography and sex. Of 18 male and 13 female patients examined, the right bronchial tree was studied in 24 and the left in 8. In one patient, a normal female, both sides were included in the survey.

TABLE I

CASE MATERIAL

(Bronchograms Performed)

Normal	*Male*	2	1	3
	Female	5	2	7
Asthma	*Male*	2	0	2
	Female	2	1	3
Chronic Bronchitis	*Male*	5	1	6
	Female	1	2	3
Emphysema	*Male*	6	1	7
	Female	1	0	1
	TOTAL	24	8	32

Bronchial Terminology

Reference to a number of authoritative works on anatomy of the tracheobronchial tree and bronchial nomenclature[21,28,30] surprisingly reveals no mention of the names of the bronchi between the trachea and the main segmental bronchi of the five pulmonary lobes. In fact, the terminology of bronchopulmonary anatomy accepted as an International Nomenclature by the Thoracic Society of Great Britain[30] with representatives of many countries, includes names for ten segmental bronchi of the right lung and nine of the left, without reference to the main stem bronchi or any of the other large hilar bronchi. Thus, since many of the bronchi measured in the present study possess no official name, it becomes necessary to indicate precisely the nomenclature used.

Proceeding distally from the tracheal bifurcation (Figure 1), each bronchus is numbered from I to V, with successive bronchi beginning at the bifurcation of its predecessor. Thus the main bronchus of each lung (main stem or 1st stage bronchus) is numbered I, the bronchus of the right lung between the upper lobe take-off and the bifurcation into middle and lower lobes (intermediate stem or 2nd stage bronchus) is numbered II, and the bronchi leading to the middle lobe and lower lobe (3rd stage bronchi) are numbered III. Bronchi of the 4th stage of the right lung are those which have been officially named in the International Nomenclature as basal bronchi of the lower lobe. Since the left lung has no large bronchus interposed between the bronchi to the upper lobe and the lower lobe, the 2nd stage bronchus on the left, numbered II, is of the same order as the 3rd stage on the right (or in each case, the lower lobe bronchi). Note should be made that the bronchi of the two lungs are numbered in succession, so that the main segmental bronchus of the right lower lobe is numbered IV and that of the left lower lobe III.

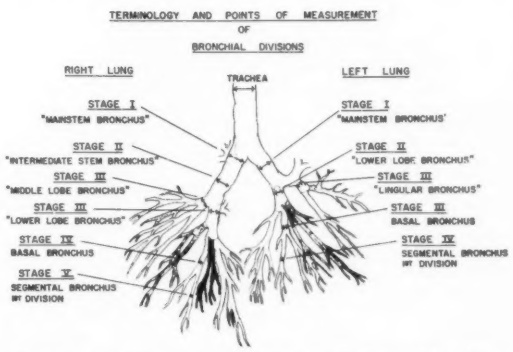


Figure 1 — Diagram of the tracheobronchial tree, showing bronchial terminology and indicating points of measurement of each bronchial division.

Technique of Measurement

Measurements were made of five successive bronchial divisions of the right lung and four of the left. In each lung, two different bronchi of the 3rd stage were measured for comparison. The points of reference for measurement are indicated in detail in Table II and are shown diagrammatically in Figure 1.

Measurements were made from single frames of the cine film projected from a standard analyser type projector which reflected the image off a mirror on to a frosted glass plate. Projection distance was approximately 30 inches, producing a circular image on the frosted glass plate of about 8 inches in diameter or, in effect, the same diameter as the original fluoroscopic image. These distances were not critical however, since an automatic correction factor for image magnification was present in all cases in the form of the radiopaque tip of the bronchial catheter. In each case, the true length of the catheter tip was measured before or after bronchography. Since the catheter was endobronchial in position during exposure of the cine film, measurement of the length of the catheter tip on the projected image allowed a correction factor for magnification to be applied to all bronchial measurements in each case.

TABLE II

BRONCHIAL TERMINOLOGY, AND POINTS OF REFERENCE FOR BRONCHIAL MEASUREMENT

Bronchial Division	RIGHT LUNG	LEFT LUNG
I	**"Mainstem Bronchus"** At a point equidistant from the tracheal carina and the take-off of the bronchus to the upper lobe.	**"Mainstem Bronchus"**
II	**"Intermediate Stem Bronchus"** At a point equidistant from the take-off of the upper lobe bronchus and the bifurcation into the middle lobe and lower lobe bronchi.	**"Lower Lobe Bronchus"** At a point within 4 mm. distal to the take-off of the apical bronchus of the lower lobe.
III	**"Lower Lobe Bronchus"** At a point within 5 mm. distal to the take-off of the apical bronchus of the lower lobe. **"Middle Lobe Bronchus"** At a point within 5 mm. of its origin from the "intermediate stem bronchus."	**"Basal Bronchus of Lower Lobe"** At a point equidistant from its origin from the "lower lobe bronchus" and its distal bifurcation. **"Lingular Bronchus"** At a point within 5 mm. distal to its origin from the "upper lobe bronchus."
IV	**"Basal Bronchus of Lower Lobe"** At a point equidistant from its origin from the basal bronchus and its distal bifurcation.	**"1st Division Segmental Bronchus Beyond Basal Bronchus"** At a point equidistant from its origin from the basal bronchus and its distal bifurcation.
V	**"1st Division Segmental Bronchus Beyond Basal Bronchus"** At a point equidistant from its origin from the basal bronchus and its distal bifurcation.	

Bronchial measurements were made at the following three phases of the respiratory cycle:

1) Maximum inspiratory calibre — (MIC) — maximum diameter at the end of full inspiration.
2) Quiet expiratory calibre — (QEC) — minimum diameter at the end of quiet expiration.
3) Forced expiratory calibre — (FEC) — minimum diameter during the expulsive phase of coughing, or at the end of forced expiration.

Measurements were made of each division on at least three different frames of the cine film during each of these phases of respiration, and the greatest or least of these were recorded depending on the phase being assessed.

All measurements were made from the outer layer of opaque medium, perpendicular to the bronchial walls and at the points indicated in Figure 1 and Table II. The lack of sharpness of definition of the column of opaque medium lining the walls was a possible source of error only in Stage V. In all other divisions, the outer border of the opaque column was sharp enough to allow measurements to the nearest 0.5 mm. at the usual magnification of the image. In some cases, the borders of Stage V bronchi were a little fuzzy, but any case was discarded in which reasonable accuracy was not considered possible.

It might be objected that the peculiar "horseshoe" shape of the cross section of the trachea and of bronchial Stages I and II, caused by cartilage rings and the posterior membranous sheet, could lead to inaccurate measurement since these tubes are not round. Although the transverse diameters of these bronchi is greater than the antero-posterior diameter, all exposures from which their measurements were made were with the patient either in a true frontal plane, or rotated 15° to 20° toward the side being examined. In order to study possible errors from this

cause, a segment of tracheobronchial tree was obtained from a cadaver, and its image was projected on to a screen from a point source of light. No significant variation in diameter occurred until the specimen was rotated at least 40° to 45°. The maximal error in diameter that could occur with rotation of a true semicircle through 20° was found to be 6%, an insignificant figure. It is reasonable to assume then that degrees of rotation of the patient during cinefluorography, at least within the ranges employed in this study, are unlikely to prejudice the accuracy of the measurements.

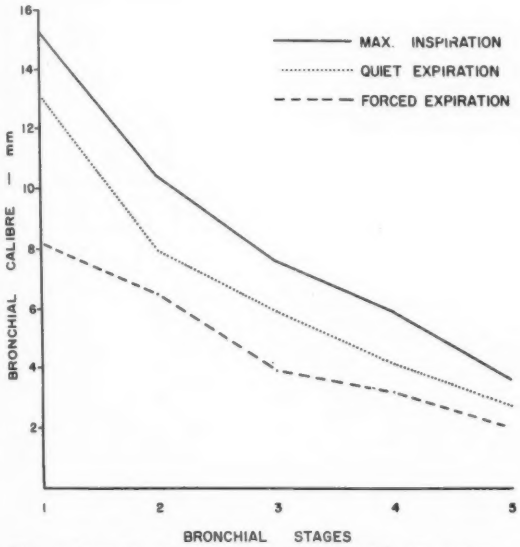


Figure 2 — Graph of mean bronchial diameters (mm.) of five divisions of the right lung in each of three phases of respiration — 7 *normal subjects*. Note the general trend to linearity in each phase of respiration.

The diameter of the trachea and of bronchial Stages I and II during the forced expiratory phase of coughing do not take into account the invagination of the posterior membranous portion into the bronchial lumen. While it must be admitted that the degree of this invagination is a factor of potential significance in reducing the cross-sectional area of the trachea in forced expiration, it is doubtful if it plays a major role in the dynamics of the larger bronchi. In any event the magnitude of this factor could not be assessed with accuracy with the techniques employed.

The possible influence of the premedication and the local anesthetic on bronchial calibre is unknown since, as yet, bronchograms have not been performed by us without the use of these drugs. However, since the action of the premedication is entirely central and that of the local anesthetic superficial, it seems unlikely that this factor would have had any major influence on the measurements.

A more serious problem is whether the opaque medium might not act as a plug in a bronchus by completely filling its lumen, thereby obstructing airflow and preventing normal changes in bronchial calibre. Such a possibility is a very real one in the bronchi distal to Stages V and VI and, in fact, a bolus of opaque medium could frequently be seen to move proximally and distally in some of the peripheral bronchi with expiration and inspiration. This phenomenon is readily understandable when it is recognized that a volume of 15 cc. of opaque medium is situated in a dead air space, the volume of which is only 70 or 80 cc. in full inspiration. In the larger bronchi, under present consideration however, the opaque medium tends to line the walls in a thin layer, particularly with frequent deep inspiration, so that it seems unlikely that this factor seriously affects the calibre of the bronchi being measured.

Results

In Table III are recorded the diameters of all bronchi according to the clinical group in which the patient was classified, and to the phase of respiration in which measurements were made. It will be noted that the range of recorded diameters is very considerable in several of the divisions, particularly in the larger bronchi. The reason for this wide range is not clear. Certainly it bears no relationship to age, since bronchial calibres of patients grouped in decades follow no definite pattern. A significant variation between the sexes is present however, the diameters of the first three bronchial divisions being consistently larger in men than in women by an average of 1.8 mm. in the right lung and 2.8 mm. in the left. The difference is less marked in the more distal bronchi. A possible relationship to certain parameters of physique, such as height, weight and surface area, has not been assessed, but Kiriluk and Merendino[23] found no such relationship to exist in their series on cadavers.

In order to assess the relationship of the diameter of each bronchus to its immediate proximal and distal divisions, the mean calibre of the bronchi of the right lung in the three phases of respiration has been plotted against each bronchial division in the 7 patients classified as normal (Figure 2). Superimposed upon this in Figure 3, for contrast, is a graph of the mean calibre of all measured bronchi of the right lung in the 13 patients with chronic bronchitis or emphysema.

TABLE III

AVERAGE CALIBRES (mm.) OF FIVE BRONCHI OF THE RIGHT LUNG AND FOUR OF THE LEFT LUNG IN THREE PHASES OF RESPIRATION AND IN EACH OF FOUR CLINICAL GROUPS

RIGHT LUNG

Clinical Group	Phase of Respiration	Bronchial Division I (Mainstem)	II (Intermediate Stem)	III (Bronchus to L.L.)	IV (Bronchus to M.L.)	IV (Basal Bronchus)	V (1st Segmental Bronchus)
Normal (7 patients)	M I *	15.3 (12 - 19)	10.4 (8.5 - 14.5)	7.6 (5.5 - 10)	5.9 (4.5 - 7.5)	5.9 (4.5 - 7.5)	3.6 (3 - 6)
	Q E †	13.2 (9 - 16)	8.0 (6.5 - 9)	5.9 (4 - 8)	4.6 (3 - 6.5)	4.1 (2 - 5)	2.7 (2 - 3.5)
	F E *†	8.2 (5 - 11)	6.5 (4.5 - 8.5)	3.9 (3 - 4.5)	2.9 (2 - 4)	3.2 (2 - 4)	2.0 (2 - 2)
Asthma (4 patients)	M I	14.5 (13.5 - 16)	10.7 (10 - 11)	8.0 (7 - 9)	6.1 (5.5 - 7.5)	6.0 (5 - 6.5)	3.6 (3 - 5)
	Q E	12.0 (11.5 - 13.5)	8.2 (7.5 - 9.5)	5.9 (5 - 6.5)	4.6 (4 - 5)	3.6 (3 - 4.5)	2.9 (2.5 - 3.5)
	F E	8.0 (7 - 9.5)	6.6 (5 - 7)	4.5 (3 - 6)	4.2 (3 - 5)	2.8 (2.5 - 3)	2.5 (2 - 3)
Chronic Bronchitis (6 patients)	M I	15.0 (13.5 - 16)	13.2 (11 - 16)	8.6 (7 - 9.5)	6.3 (5.5 - 7.5)	5.2 (4.5 - 6)	3.8 (3 - 4.5)
	Q E	12.7 (12 - 14)	11.1 (9 - 14)	6.6 (5.5 - 8)	4.7 (4 - 6)	3.7 (3 - 4.5)	3.5 (3 - 4)
	F E	6.6 (4.5 - 11)	7.2 (5 - 10)	2.8 (1.5 - 3.5)	2.7 (1.5 - 3.5)	3.0 (2 - 4)	2.6 (2 - 3.5)
Emphysema (7 patients)	M I	14.9 (13 - 19)	13.2 (12 - 17)	9.0 (7.5 - 11.5)	6.2 (4.5 - 8.5)	6.0 (5 - 7.5)	4.1 (2.5 - 5)
	Q E	12.9 (11 - 15.5)	9.9 (7.5 - 11.5)	6.4 (4 - 8.5)	4.6 (2 - 7.5)	4.0 (2 - 5.5)	3.0 (2 - 3.5)
	F E	6.9 (5 - 8.5)	5.8 (4.5 - 7.5)	3.0 (1.5 - 4)	2.6 (1.5 - 4)	3.1 (2 - 4.5)	2.7 (1.5 - 4.5)

LEFT LUNG

Clinical Group	Phase of Respiration	Bronchial Division I (Mainstem)	II (Bronchus to Lower Lobe)	III (Basal Bronchus)	III (Bronchus to Lingula)	IV (1st Segmental Bronchus)
Normal (3 patients)	M I *	13.0 (11 - 12)	11.0 (9 - 13.5)	5.8 (5 - 6.5)	7.5 (6 - 9)	4.8 (4.5 - 5.5)
	Q E †	9.3 (5 - 13.5)	8.2 (6.5 - 10.5)	4.5 (3.5 - 5)	6.0 (4.5 - 7)	3.7 (3.5 - 4)
	F E *†	7.0 (5 - 9)	5.5 (5 - 6.5)	3.0 (2.5 - 3.6)	4.5 (4.5 - 4.5)	3.2 (3 - 3.5)
Asthma (1 patient)	M I	12.5	9.0	6.5	5.0	3.5
	Q E	11.0	7.5	5.0	3.5	3.0
	F E	6.0	3.0	3.5	3.0	2.0
Chronic Bronchitis (3 patients)	M I	12.0 (11.5 - 12.5)	9.5 (8.5 - 11)	5.7 (4.5 - 7)	7.0 (5.5 - 8.5)	3.2 (2.5 - 4)
	Q E	9.8 (8.5 - 10.5)	7.2 (6 - 8.5)	4.0 (4 - 4)	5.5 (4 - 7)	2.5 (2 - 3)
	F E	6.0 (4.5 - 7.5)	4.8 (4.5 - 5.5)	3.2 (2.5 - 4)	3.3 (2.5 - 4.5)	2.2 (1.5 - 3)
Emphysema (1 patient)	M I	16.5	11.0	9.5	6.0	8.0
	Q E	14.0	6.0	7.0	4.5	4.5
	F E	4.5	1.5	3.0	2.5	4.5

* Maximum Inspiration
† Quiet Expiration
*† Forced Expiration

The figures in brackets are the range of calibre in each instance.

As a further check of the inter-relationship of successive bronchi, the calibre of bronchial Stage II of the right lung has been plotted against each of the other measured bronchi in all patients (Figure 4). Since plotting of each bronchial division against its successor showed strong linearity in the larger bronchi, but considerable scattering in the distal divisions, possibly because of compounding of error in measurement, bronchial Stage II (intermediate stem) was used as the common denominator in all graphs.

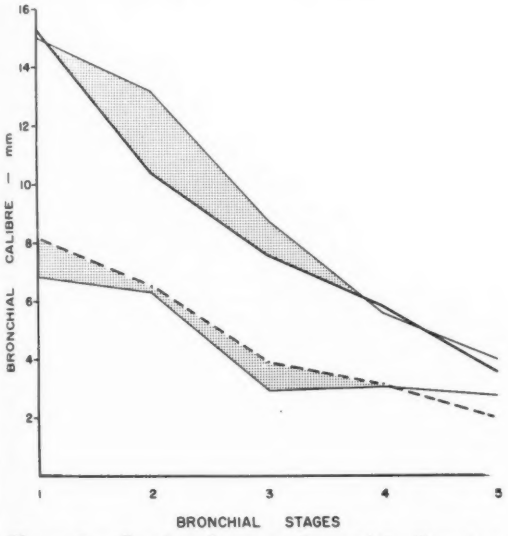


Figure 3 — Graph of mean bronchial diameters (mm.) of five divisions of the right lung in maximum inspiration and forced expiration — *13 patients with chronic bronchitis or emphysema* (shaded area), superimposed on the graph of *7 normal subjects* (clear area — see Figure 2). Note the disproportionate reduction in calibre from maximum inspiration to forced expiration, in Stages I, II and III in chronic bronchitis and emphysema, compared to the normal group.

In Figure 5 the diameter of bronchial Stage II of the right lung of all patients is plotted against the *sum* of the diameters of those bronchi arising from it (bronchi to middle lobe and lower lobe, which are both Stage III bronchi).

Discussion

The relationship between a bronchus and its proximal and distal divisions, as depicted in Figures 2 to 5, shows good general linearity, particularly well seen in Figure 2. In other words, the diameter of each successive bronchial division is roughly proportional to the diameter of its predecessor in the same ratio for all bronchi through Stages I to V. Similarly the graphs in Figure 4 all demonstrate consistent grouping of points on the appropriate side of the 45° line. For example, the Stage I bronchus of all patients is consistently greater in diameter than the Stage II bronchus, and Stages III, IV and V bronchi are all less in diameter than Stage II. The grouping suggests a definite trend to linearity, particularly between the larger bronchi.

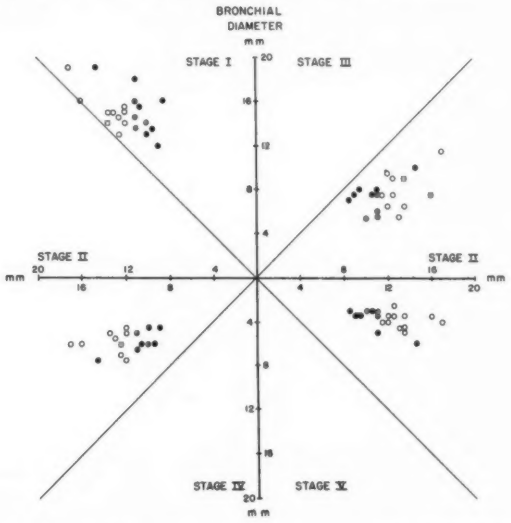


Figure 4 — Graphs of the diameter of bronchial Stage II of the right lung plotted against the diameter of each of the other measured bronchi — 7 normal subjects and 13 patients with chronic bronchitis or emphysema. Bronchial Stage II forms the common ordinate. Note consistent grouping of points on the appropriate side of the 45° line, and a rough trend to linearity in each relationship, independent of whether the lung is normal or the site of chronic bronchitis or emphysema.

In Figure 5 it will be observed that all points are consistently situated above the 45° line, indicating that the sum of calibres of bronchi arising from a bronchus is greater than that of its parent. Again, grouping of points would appear to suggest that rough linearity exists in this comparison.

Since cross-sectional area of these tubes is proportional to diameter, it would appear reasonable to suggest that a distinct relationship exists between the cross-sectional area of a bronchus and those bronchi distal to it, at least as far as Stage V.

Whenever possible, measurements of the trachea were made in both maximum inspiration and forced expiration, but were felt to be accurate in only thirteen of the thirty-two bronchograms assessed. In these thirteen cases, from all four clinical groups, the average maximum inspiratory calibre was 18.0 mm., a figure which seems reasonable if extrapolated on the graph for maximum calibres in Figure 3. Percentage reduction in tracheal calibre from maximum inspiration

TABLE III

AVERAGE CALIBRES (mm.) OF FIVE BRONCHI OF THE RIGHT LUNG AND FOUR OF THE LEFT LUNG IN THREE PHASES OF RESPIRATION AND IN EACH OF FOUR CLINICAL GROUPS

RIGHT LUNG

Clinical Group	Phase of Respiration	I (Mainstem)	II (Intermediate Stem)	III (Bronchus to L.L.)	IV (Bronchus to M.L.)	IV (Basal Bronchus)	V (1st Segmental Bronchus)
Normal (7 patients)	M I *	15.3 (12 - 19)	10.4 (8.5 - 14.5)	7.6 (5.5 - 10)	5.9 (4.5 - 7.5)	5.9 (4.5 - 7.5)	3.6 (3 - 6)
	Q E †	13.2 (9 - 16)	8.0 (6.5 - 9)	5.9 (4 - 8)	4.6 (3 - 6.5)	4.1 (2 - 5)	2.7 (2 - 3.5)
	F E *†	8.2 (5 - 11)	6.5 (4.5 - 8.5)	3.9 (3 - 4.5)	2.9 (2 - 4)	3.2 (2 - 4)	2.0 (2 - 2)
Asthma (4 patients)	M I	14.5 (13.5 - 16)	10.7 (10 - 11)	8.0 (7 - 9)	6.1 (5.5 - 7.5)	6.0 (5 - 6.5)	3.6 (3 - 5)
	Q E	12.0 (11.5 - 13.5)	8.2 (7.5 - 9.5)	5.9 (5 - 6.5)	4.6 (4 - 5)	3.6 (3 - 4.5)	2.9 (2.5 - 3.5)
	F E	8.0 (7 - 9.5)	6.6 (5 - 7)	4.5 (3 - 6)	4.2 (3 - 5)	2.8 (2.5 - 3)	2.5 (2 - 3)
Chronic Bronchitis (6 patients)	M I	15.0 (13.5 - 16)	13.2 (11 - 16)	8.6 (7 - 9.5)	6.3 (5.5 - 7.5)	5.2 (4.5 - 6)	3.8 (3 - 4.5)
	Q E	12.7 (12 - 14)	11.1 (9 - 14)	6.6 (5.5 - 8)	4.7 (4 - 6)	3.7 (3 - 4.5)	3.5 (3 - 4)
	F E	6.6 (4.5 - 11)	7.2 (5 - 10)	2.8 (1.5 - 3.5)	2.7 (1.5 - 3.5)	3.0 (2 - 4)	2.6 (2 - 3.5)
Emphysema (7 patients)	M I	14.9 (13 - 19)	13.2 (12 - 17)	9.0 (7.5 - 11.5)	6.2 (4.5 - 8.5)	6.0 (5 - 7.5)	4.1 (2.5 - 5)
	Q E	12.9 (11 - 15.5)	9.9 (7.5 - 11.5)	6.4 (4 - 8.5)	4.6 (2 - 7.5)	4.0 (2 - 5.5)	3.0 (2 - 3.5)
	F E	6.9 (5 - 8.5)	5.8 (4.5 - 7.5)	3.0 (1.5 - 4)	2.6 (1.5 - 4)	3.1 (2 - 4.5)	2.7 (1.5 - 4.5)

LEFT LUNG

Clinical Group	Phase of Respiration	I (Mainstem)	II (Bronchus to Lower Lobe)	III (Basal Bronchus)	III (Bronchus to Lingula)	IV (1st Segmental Bronchus)
Normal (3 patients)	M I *	13.0 (11 - 12)	11.0 (9 - 13.5)	5.8 (5 - 6.5)	7.5 (6 - 9)	4.8 (4.5 - 5.5)
	Q E †	9.3 (5 - 13.5)	8.2 (6.5 - 10.5)	4.5 (3.5 - 5)	6.0 (4.5 - 7)	3.7 (3.5 - 4)
	F E *†	7.0 (5 - 9)	5.5 (5 - 6.5)	3.0 (2.5 - 3.6)	4.5 (4.5 - 4.5)	3.2 (3 - 3.5)
Asthma (1 patient)	M I	12.5	9.0	6.5	5.0	3.5
	Q E	11.0	7.5	5.0	3.5	3.0
	F E	6 0	3.0	3.5	3.0	2.0
Chronic Bronchitis (3 patients)	M I	12.0 (11.5 - 12.5)	9.5 (8.5 - 11)	5.7 (4.5 - 7)	7.0 (5.5 - 8.5)	3.2 (2.5 - 4)
	Q E	9.8 (8.5 - 10.5)	7.2 (6 - 8.5)	4.0 (4 - 4)	5.5 (4 - 7)	2.5 (2 - 3)
	F E	6.0 (4.5 - 7.5)	4.8 (4.5 - 5.5)	3.2 (2.5 - 4)	3.3 (2.5 - 4.5)	2.2 (1.5 - 3)
Emphysema (1 patient)	M I	16.5	11.0	9.5	6.0	8.0
	Q E	14.0	6.0	7.0	4.5	4.5
	F E	4.5	1.5	3.0	2.5	4.5

* Maximum Inspiration
† Quiet Expiration
*† Forced Expiration

The figures in brackets are the range of calibre in each instance.

As a further check of the inter-relationship of successive bronchi, the calibre of bronchial Stage II of the right lung has been plotted against each of the other measured bronchi in all patients (Figure 4). Since plotting of each bronchial division against its successor showed strong linearity in the larger bronchi, but considerable scattering in the distal divisions, possibly because of compounding of error in measurement, bronchial Stage II (intermediate stem) was used as the common denominator in all graphs.

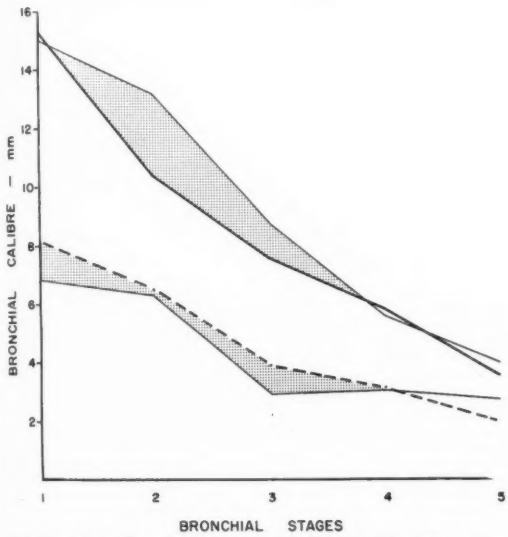
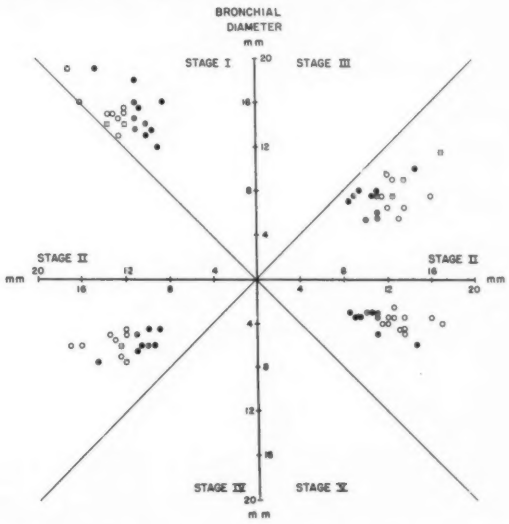


Figure 3 — Graph of mean bronchial diameters (mm.) of five divisions of the right lung in maximum inspiration and forced expiration — *13 patients with chronic bronchitis or emphysema* (shaded area), superimposed on the graph of *7 normal subjects* (clear area — see Figure 2). Note the disproportionate reduction in calibre from maximum inspiration to forced expiration, in Stages I, II and III in chronic bronchitis and emphysema, compared to the normal group.

In Figure 5 the diameter of bronchial Stage II of the right lung of all patients is plotted against the *sum* of the diameters of those bronchi arising from it (bronchi to middle lobe and lower lobe, which are both Stage III bronchi).

Discussion

The relationship between a bronchus and its proximal and distal divisions, as depicted in Figures 2 to 5, shows good general linearity, particularly well seen in Figure 2. In other words, the diameter of each successive bronchial division is roughly proportional to the diameter of its predecessor in the same ratio for all bronchi through Stages I to V. Similarly the graphs in Figure 4 all demonstrate consistent grouping of points on the appropriate side of the 45° line. For example, the Stage I bronchus of all patients is consistently greater in diameter than the Stage II bronchus, and Stages III, IV and V bronchi are all less in diameter than Stage II. The grouping suggests a definite trend to linearity, particularly between the larger bronchi.



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In Figure 5 it will be observed that all points are consistently situated above the 45° line, indicating that the sum of calibres of bronchi arising from a bronchus is greater than that of its parent. Again, grouping of points would appear to suggest that rough linearity exists in this comparison.

Since cross-sectional area of these tubes is proportional to diameter, it would appear reasonable to suggest that a distinct relationship exists between the cross-sectional area of a bronchus and those bronchi distal to it, at least as far as Stage V.

Whenever possible, measurements of the trachea were made in both maximum inspiration and forced expiration, but were felt to be accurate in only thirteen of the thirty-two bronchograms assessed. In these thirteen cases, from all four clinical groups, the average maximum inspiratory calibre was 18.0 mm., a figure which seems reasonable if extrapolated on the graph for maximum calibres in Figure 3. Percentage reduction in tracheal calibre from maximum inspiration

to forced expiration varied from 33% to 70%, with more narrowing in the chronic bronchitic and emphysema groups (average 63%) than in the other groups (average 39%). As in the bronchi, narrowing occurred extremely rapidly, usually in less than 30 milliseconds, with the resulting appearance of the so-called "tracheal wink." Infolding of the posterior membranous portion of the tracheal wall was frequently seen but was not measured.

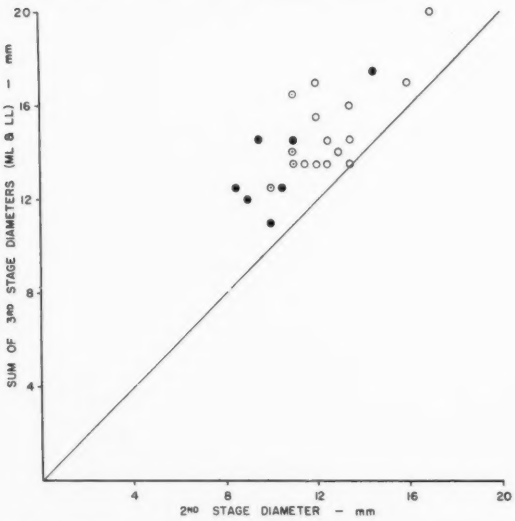

Figure 5 — Graph of the diameter of bronchial Division II of the right lung plotted against the *sum* of the diameters of those bronchi arising from it (bronchial Stage III — main lobar bronchi to middle lobe and lower lobe) — *7 normal subjects and 13 patients with chronic bronchitis and emphysema.* Note that all points are consistently above the 45° line, indicating that the sum of the diameters of bronchi arising from a bronchus is greater than that of its parent. Grouping of points would suggest that rough linearity exists in this relationship.

It is interesting that the measurements of the trachea and both Stage I bronchi obtained in the present series correspond closely to the averages obtained by Kiriluk and Merendino[23] in their study on cadavers. These authors recorded an average tracheal calibre of 19.0 mm. compared to our 18.0 mm. Similarly, the diameters of both Stage I bronchi obtained by these authors are close to our figures, being identical for Stage I on the left (13.0 mm.) and slightly greater for Stage I on the right (16.0 mm. as against 15.0 mm. in the present series).

No attempt was made to measure in length the alteration of the bronchi or trachea on deep respiration or coughing, but all segments were consistently observed to elongate on inspiration and shorten on expiration. In almost all cases in which a satisfactory Valsalva procedure was recorded cinefluorographically, the diameters of the various bronchi measured were slightly *less* than their maximum inspiratory calibre.

The response of the bronchi to quiet expiration and forced expiration in the four clinical groups showed certain differences which are of considerable interest. Table III shows that little variation in calibre is present between the normal and asthmatic groups, measurements being roughly similar in all divisions and in all phases of respiration. In the chronic bronchitic and emphysema groups, however, certain differences appear which are striking when viewed cinefluorographically. A normal tracheobronchial tree viewed cinefluorographically at 30 frames per second during coughing will reveal a roughly proportional reduction in the calibre of all bronchi from maximum calibre in inspiration to minimum calibre during coughing (Figure 6A), an impression which is borne out by the measurements (Figure 2). In contrast however, patients with chronic bronchitis or emphysema, or both, will almost invariably show a remarkable collapse of their central bronchi during coughing (Figure 6B), particularly of the main lobar bronchi (Stage III of the right lung and Stage II of the left). For example, in one patient with bronchitis and emphysema, the actual calibre reduction of the lower lobe bronchus was from 11 mm. to 1.5 mm. (86%) while the segmental bronchus in the same patient reduced from 8 mm. to 5 mm. (38%). Thus, at the point of maximum narrowing, the segmental bronchus was over three times the calibre of the *main* lower lobe bronchus. This reversal of the ratio of lower lobe bronchus to segmental bronchus occurred frequently in patients with chronic bronchitis, the large bronchus collapsing down to almost a linear shadow and presenting a striking contrast to the several segmental bronchi of larger calibre distal to it (Figure 6B).

These observations are confirmed by the measurements recorded in Table III and in Figure 3. In this figure the graph reproduced in Figure 2, representing the normal bronchial tree, has superimposed upon it the mean of the maximum inspiratory calibre and forced expiratory calibre in the 13 patients with chronic bronchitis or emphysema. Major differences are seen in the first three bronchial divisions, all of which show a greater than normal reduction in calibre in response to cough. In each division the deviation from normal is greatest on different sides of the normal scale: in Stage I, the inspiratory calibres are equal, but there is greater reduction in expiratory calibre in chronic bronchitis or emphysema. In Stage II, the maximum inspiratory calibre is considerably greater than normal, but the forced expiratory

calibre is the same as normal, and in Stage III, maximum inspiratory calibre is greater and forced expiratory calibre smaller than in the normal group. In each case, however, the sum of these effects is to produce a more pronounced calibre change of these bronchi in response to forced expiration or cough. The calibre of Stage IV is the same in both groups of patients, and Stage V actually has a greater calibre in all respiratory phases in the chronic bronchitic and emphysema group than in the normal.

The greater response to forced expiration of the bronchi in chronic bronchitis and emphysema compared to normal can perhaps be more clearly appreciated when expressed as a percentage of maximum inspiratory calibre. From maximum inspiration to forced expiration, the calibre of Stage I is reduced by 47% in normal patients and by 55% in chronic bronchitis. Stage II reduces by 38% in normals and 53% in chronic bronchitis. Stage III reduces by 49% in normals and 67% in chronic bronchitis. Similar figures for bronchial Stages IV and V are 46%/45% and 45%/32% respectively, so that there is actually *less* change of the peripheral bronchi in the chronic bronchitis group than in normals.

This tendency for central bronchi to collapse in forced expiration in patients with chronic bronchitis or emphysema has been observed repeatedly by other workers, both radiologically and endoscopically[8,14,16,29], and has been suggested as a possible pathogenetic mechanism of expiratory obstruction in these diseases[5,16,12,20]. It is tempting to explain this collapse on certain theoretical grounds based on abnormalities in intrathoracic and transbronchial pressures, changes in airflow characteristics, bronchial wall softening and other influences. Such speculation, however, would serve little purpose. It is obviously necessary to relate alterations in bronchial calibre to simultaneous recording of intrabronchial and intrathoracic pressure, and possibly with bronchial airflow, before any statement can

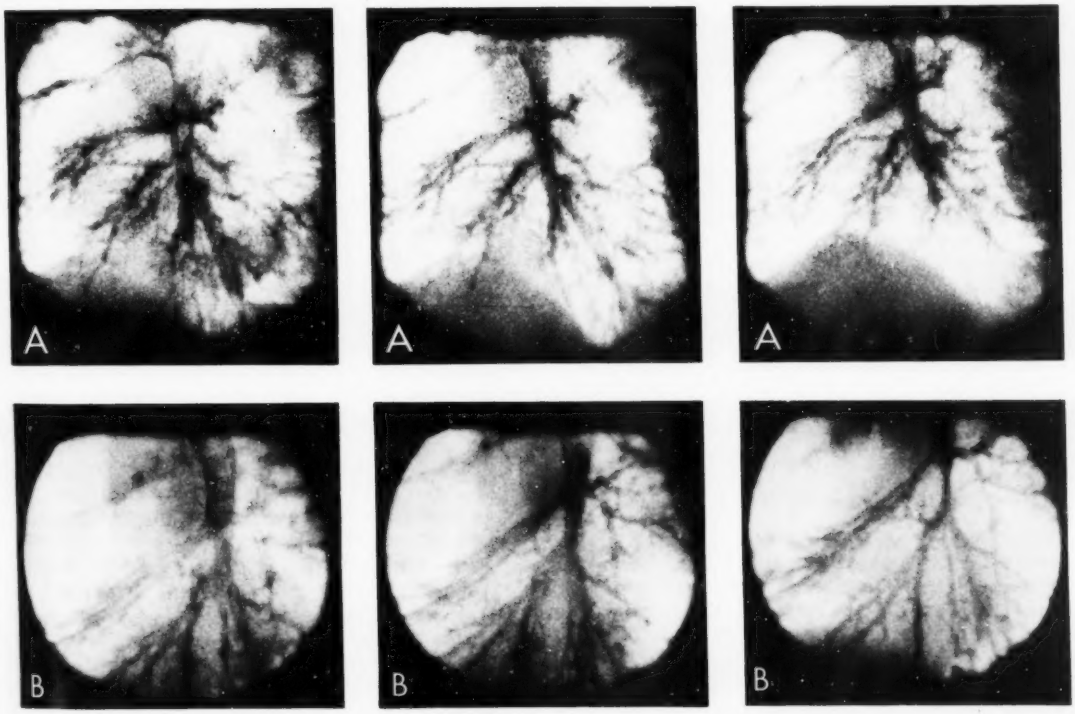

Figure 6 — Three frames of representative cine strips from two right bronchograms of (a) a normal patient, and (b) a patient with chronic bronchitis and emphysema. In each example the camera speed was 30 frames per second, and the range of respiration from maximum inspiration (left frame) to forced expiration (right frame). In (a) the sequence covers 10 frames, so that the time interval was one-third of a second. Note the roughly proportionate reduction in diameter of all bronchi from maximum calibre in inspiration to minimum calibre in forced expiration. In (b) the sequence covers 5 frames, so that the time interval was about one-sixth of a second. Note the collapse of the lower lobe bronchus (Stage III) from inspiration to forced expiration (arrows). In the right frame, the diameter of the lower lobe bronchus is about one-third the diameter of each of the basal bronchi arising from it.

be made whether the changes observed in disease are a principle mechanism of airflow reduction or simply a consequence of abnormalities of pressure change caused by pathologic alteration in the terminal bronchioles or elsewhere.

In recent years, the works of Simon and Galbraith[27], Lynne Reid[25] and others[11] have greatly clarified certain diagnostic features of the bronchographic changes in chronic bronchitis and emphysema. Apart from the filling of dilated mucus glands in the major bronchi in chronic bronchitis, the major bronchographic changes in chronic bronchitis and bronchiolitis exist in the peripheral air passages — Stages VI and VII bronchi and the bronchioles. Irregularities of calibre of the small bronchi, narrowing and obliteration of larger bronchioles, and bronchiolar "pools" and "spikes" are all signs which indicate severe disease, and which obviously cannot be appreciated bronchographically unless these divisions are adequately outlined with opaque medium. We have been repeatedly impressed with the inadequacy of bronchograms in which peripheral filling has been slight or absent, and have shown on post-tussic radiographic and cinefluorographic studies many changes in the peripheral bronchiolar tree which were not evident before coughing. Contrary to some current belief, the expulsive wave of gas accompanying a cough does not propel bronchial contents peripherally. Holden and Ardran[17] observed that opaque material was never seen to pass distally during the expulsive wave of a cough, and our observations confirm this. What a cough does accomplish, however, is a deep inspiration before the expulsion, and it is this inspiratory phase that propels the opaque material peripherally. The importance of coughing in the assessment of the *whole* bronchial tree cannot be overstressed. Not only can bronchial calibre changes be studied if cinefluorography is available, but equally important is the part the inspiratory phase of cough plays in bronchiolar visualization.

Summary

1. During the past two years, fifty-five bronchograms have been performed utilizing cinefluorographic in addition to fluoroscopic and radiographic techniques in an attempt to assess functional as well as morphological changes in the tracheobronchial tree.

2. In several patients, considerable variation has been observed in the calibre of bronchi of the same division in response to different phases of respiration, particularly forced expiration. In order to assess the magnitude of this variation quantitatively, measurements have been made of five divisions of thirty-two bronchial trees of thirty-one patients comprising seven normals, four with spasmodic asthma, six with chronic bronchitis and seven with emphysema. Measurements of each of the five divisions in all patients have been made in maximum inspiration, quiet expiration and forced expiration.

3. The calibre of each successive bronchial division is roughly proportional to the calibre of its predecessor in the same ratio for all bronchi through Stages I to V.

4. The relationship between the calibre of successive bronchi in maximum inspiration is constant in all patients.

5. Significant differences have been observed between the clinical groups in the change in calibre of the larger bronchi in response to forced expiration. While the reduction in calibre of all five divisions in the normal patients is roughly uniform, the 3rd stage bronchus of the majority of patients with chronic bronchitis or emphysema has shown a disproportionate tendency to collapse in forced expiration.

6. It will be necessary to relate alterations in bronchial calibre to simultaneous recording of intrabronchial and intrathoracic pressure, and possibly with bronchial airflow, before any statement can be made as to whether the changes observed in disease constitute a primary mechanism of airflow reduction, or are a consequence of pressure changes produced by structural alterations in the terminal bronchioles or elsewhere.

7. The value of deep breathing and coughing in the demonstration of bronchographic abnormalities in chronic bronchitis and bronchiolectasis is stressed.

ACKNOWLEDGMENT: I wish to thank Dr. David V. Bates for his stimulation, encouragement and advice, and for his careful review and criticism of the manuscript.

Résumé

1. Au cours des deux dernières années, les auteurs ont étudié les changements fonctionnels et morphologiques de l'arbre trachéobronchique à l'aide de la cinéfluorographie, en plus des examens fluoroscopiques et radiographiques.

2. Chez plusieurs patients, une variation considérable fut observée dans le calibre des bronches d'une même division lors des différentes phases respiratoires, surtout en expiration forcée. En vue de déterminer l'importance quantitative de cette variation, des mesures des cinq divisions bronchiques ont été faites à trente-deux reprises chez trente-et-un patients. Ces patients se répartissaient comme suit: sept cas normaux, quatre cas d'asthme spasmodique, six cas de bronchite chronique et sept cas d'emphysème. Les mesures de chacune des cinq divisions bronchiques ont été prises en inspiration profonde, en expiration normale et en expiration forcée.

3. Le calibre de chacune des divisions bronchiques est approximativement proportionnel à celui de la précédente, dans la même proportion pour toutes les bronches de I à V.

4. La relation entre le calibre des bronches successives en inspiration profonde est constante chez tous les patients.

5. Des différences significatives ont été observées parmi les groupes cliniques dans le changement de calibre des bronches principales lors de l'expiration forcée. Alors que la diminution de calibre des cinq divisions bronchiques était à peu près uniforme chez les patients normaux, la troisième division bronchique montrait une tendance disproportionnée à s'affaisser en expiration forcée chez la plupart des patients souffrant de bronchite chronique ou d'emphysème.

6. Il sera nécessaire d'étudier les variations du calibre bronchique en relation avec un tracé simultané de la pression intra-bronchique et intra-thoracique, et peut-être du débit de ventilation bronchique. Ceci permettra d'affirmer si les variations observées dans la maladie correspondent à un mécanisme fondamental de réduction du débit de la ventilation bronchique, ou si elles sont secondaires aux changements de pression engendrés par des modifications structurales aux bronchioles terminales ou ailleurs.

7. La respiration profonde et la toux sont d'une grande valeur dans la production des anomalies bronchographiques de la bronchite chronique et de l'ectasie bronchiolaire.

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LA SIGNIFICATION D'UN NIVEAU LIQUIDE DANS LE SINUS SPHÉNOIDAL APRÈS UN TRAUMATISME CRÂNIEN *

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Depuis plusieurs années, notre attention a été attirée sur la fréquence d'un niveau liquide dans le sinus sphénoidal, découvert lors des examens du crâne chez les traumatisés.

En quatre ans, nous avons pu observer une trentaine de cas où ce phénomène s'est produit et nous avons voulu, par une étude approfondie des signes cliniques et des complications survenues chez chacun de ces malades, nous faire une idée exacte de sa signification.

A prime abord, il semblait bien s'agir d'un signe indirect de fracture de la base du crâne, intéressant le sphénoide, avec hémorrhagie dans le sinus. Mais dans quelles circonstances et dans quel contexte clinique, cette constatation a-t-elle une valeur absolue? Malheureusement, aucun des 33 cas observés n'a été confirmé par une étude anatomique post-mortem, de même qu'aucune ponction du sinus sphénoidal n'a été faite pour retirer le liquide et en faire l'analyse. Nos conclusions seront donc basées sur l'appréciation des signes objectifs constatés cliniquement et interprétés assez souvent à la lumière des constatations chirurgicales rapportées par les neurochirurgiens, et confirmés un certain nombre de fois par l'évolution clinique de nos malades.

Tous les malades sans exception ont été hospitalisés et observés pour une période d'au moins trois jours.

Seulement 5 cas ne présentaient pas de fracture du crâne visible sur les radiographies.

L'examen radiologique est habituellement fait assez tôt après l'admission à la clinique d'urgence. Cet examen comprend, entre autres, une incidence latérale avec rayon horizontal et avec cassette-grille. Si cette simple incidence avait été employée plus régulièrement dans les débuts, même chez les malades ambulants, après un traumatisme apparemment bénin, nous avons l'impression que le nombre de cas avec niveaux liquides intra-sphénoidaux serait plus considérable.

Nous n'hésitons pas aujourd'hui à recommander cette incidence de routine pour tout traumatisé du crâne, quelle que soit la violence apparente du traumatisme. Une étude des os et des sinus de la face devrait également être systématique dans ces cas.

Pour faciliter l'analyse, ces cas ont été divisés en quatre groupes, selon les constatations radiologiques.

1. Les fractures du crâne intéressant les sinus.
2. Les fractures de la base.
3. Les fractures de la voûte.
4. Les traumatismes sans fracture évidente.

Parmi les 33 cas, 30 avaient des symptômes et des signes nets de fracture de la base.

Le premier tableau nous fait connaître la répartition de ces 30 cas, dans chacun des groupes.

TABLEAU I

A.	Fracture du crâne intéressant les sinus	13 - 40%
B.	Fracture de la voûte	7
C.	Fracture de la base	7
D.	Aucune évidence de fracture	3

Le deuxième tableau nous donne les lésions intracrâniennes constatées chez ces 30 cas.

TABLEAU II

Hématôme intracrânien	16
Hémorrhagie sous-arachnoidienne	15
Pneumocéphalie	7
Déchirure duremérienne	8
Fistule duremérienne persistante	2

Le troisième tableau nous fait part des signes cliniques associés.

TABLEAU III

Perte de connaissance	24
Otorrhée	14
Rhinorrhée	14

* *Travail présenté au Congrès Annuel de l'Association Canadienne des Radiologistes, 25 janvier 1961, Saint-Jean, N.B.*

Le quatrième tableau signale les complications plus ou moins tardives.

TABLEAU IV

Méningite septique	3
Perte de l'audition	3
Paralysie faciale	1
Anosmie	3
Anévrysme carotico-caverneux	1

L'analyse de ces cas nous fait donc constater que l'otorrhée et la rhinorrhée surviennent aussi souvent que les hématômes intra-crâniens, c'est-à-dire au moins dans la moitié des cas, alors que le pneumatocèle survient deux fois moins souvent. Evidemment, l'air intra-sinusal pénètre moins facilement dans les méninges que le liquide céphalo-rachidien peut en sortir.

Le cas le plus intéressant de la série, et celui dont on peut tirer une leçon certaine, est celui qui après une simple fracture du frontal, atteignant la lame orbitaire, mais où un niveau liquide sinusal est évident, se complique d'un anévrysme carotico-caverneux. Le niveau liquide dans le sinus sphénoidal était sûrement le témoin d'une fracture sphénoidale avec dommage carotidien important (figure 1).

Une brève étude de l'anatomie doit nous rappeler que la portion antérieure du sinus sphénoidal fait partie du plancher de la fosse antérieure. Ceci veut dire que le sinus sphénoidal peut être intéressé tout autant par une fracture de la portion postérieure de la fosse antérieure que par une fracture de la fosse moyenne.

Le niveau liquide découvert dans les sinus sphénoidaux s'accompagne dans un grand nombre de nos cas de niveaux dans les sinus frontaux ou maxillaires (figures 2 et 5).

Aucun cas n'a présenté d'histoire d'infection sinusale, d'allergie ou de médication nasale abusive. Pour cette raison, nous croyons que le liquide en cause a toujours été soit du sang, soit du liquide céphalo-rachidien ou même les deux à la fois.

Le sang ou le liquide céphalo-rachidien ont pu pénétrer dans le sinus par le canal sinusal ou s'y infiltrer par une communication sinus-duremère directe causée par une fracture du sinus.

Il est facile de comprendre que toute hémorrhagie ou tout écoulement de liquide céphalo-rachidien, survenant dans les sinus frontaux ou les cellules ethmoidales peut gagner le sinus sphénoidal par gravité. Il semble d'ailleurs que c'est ce qui a pu se passer dans 40% des cas de fracture des sinus ou de la lame criblée. Cependant, à notre avis, dans tout cas de traumatisme crânien, qui présente un niveau liquide sphénoidal, il faut envisager la possibilité d'une fracture du sinus sphénoidal.

Lewin et Cairns[5] ont déjà rapporté 5 cas de fracture du sinus sphénoidal dans lesquels l'on remarquait entre autres, des conditions bien spéciales de traumatisme, une rhinorrhée profuse, de l'air au niveau de la citerne chiasmatique et des signes d'atteinte des structures avoisinantes, tels que le thalamus, le chiasma optique ou la carotide.

Dans 30 de nos 33 cas rapportés, l'on remarque des signes variés d'atteinte des fosses antérieure ou moyenne.

De ces 30 cas, 13 cas ont eu des fractures des sinus paranasaux.

Le pourcentage élevé de rhinorrhée et de fractures sinusales nous a incités à rechercher systématiquement une fracture du plancher de la fosse antérieure avec atteinte des sinus et déchirure de la duremère.

Nous croyons pouvoir conclure de notre expérience que l'inondation exclusive du sinus sphénoidal constitue une preuve certaine que la brèche duremérienne causant la rhinorrhée est située au sphénoide plutôt que dans la lame criblée. Cette seule conclusion peut à notre avis, éviter de nombreuses explorations inutiles de la lame criblée.

En effet, il faut rechercher à fermer la brèche dans le sphénoide, si les films démontrent une transparence normale de l'ethmoide.

Tout cas de rhinorrhée devrait donc être étudié minutieusement en se rappelant la possibilité fréquente de lésion du sphénoide.

Dans les 3 cas isolés où aucun signe direct ou indirect de fracture n'a été démontré, il est assez difficile d'expliquer la présence de liquide dans le sinus sphénoidal, bien que la possibilité d'une hémorrhagie dans le sinus frontal ou dans l'ethmoide pourrait être en cause.

Ce qui voudrait dire que dans 90% des cas, ce niveau liquide devrait être considéré comme un signe indirect de fracture de la base. Il ne faut pas oublier cependant, que ce liquide peut gagner le sphénoide dans n'importe quel cas de fracture des autres sinus de la face ou dans n'importe quelle hémorrhagie nasale.

Sommaire

Chez 33 cas de traumatisme crânien l'on a trouvé un niveau liquide dans les sinus sphénoidaux. Ces niveaux liquides ont été trouvés en utilisant une projection latérale avec tube horizontal et cassette-grille. Radiologiquement, il était impossible de démontrer de fracture du sinus sphénoidal, mais 30 cas avaient des signes cliniques quasi certains de fracture de la base du crâne. La concordance de signes de fracture du crâne et d'un niveau liquide dans le sinus sphénoidal dans 90% des cas a attiré notre attention. Evidemment la présence d'un niveau liquide dans le sinus sphénoidal peut s'expliquer par une hémorragie nasale ou par une fracture des sinus de la face autres que le sinus sphénoidal. Cependant l'inondation exclusive du sinus sphénoidal peut être considérée comme un signe quasi certain de fracture de la base du crâne.

Summary

Thirty-three cases of closedhead injuries have shown an air-fluid level in the sphenoid sinus by radiological examination performed during the first hours following trauma. The so-called "brow-up lateral" is the technique used as a basic projection included in the preliminary examination of head injuries. No fracture of the spenoid sinuses was directly observed in these cases, but a detailed investigation revealed 30 cases with definite signs of injury to the base of the skull. The striking relationship between the occurrence of fractures of the base of the skull and the presence of fluid in the sphenoid sinuses in 90% of cases presented, is discussed.

Figure I — Niveau liquide dans le sinus sphénoidal chez un traumatisé, trouvé lors d'une radiographie debout, de la colonne cervicale. Quelques semaines après, le malade faisait une fistule caroticocaverneuse.

Although some authors have reported fluid in the sphenoid sinus in few cases with traumatic CSF rhinorrhea, we would like to extend the clinical significance of this extravasated fluid to include fractures of the base of the skull, since this phenomenon was a characteristic sign of basal fractures in our case material. In basal fractures as well as in less severe types of head injuries, transient and unrecognized CSF leakage and/or sinusal hemorrhage at the floor of the anterior fossa, may drain by gravity into the sphenoid sinuses because of their anatomical relationships.

It is clear from the follow-up of the patients that the presence of the air-fluid level sign by itself did not modify the prognosis.

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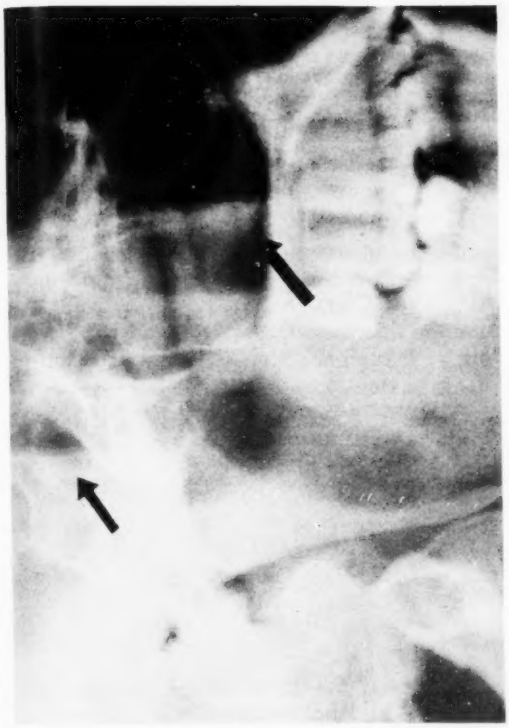

Figure II — Niveaux liquidee dans les sinus sphénoidaux et maxillaires.

Figure IV — Niveau liquide chez un malade avec fracture de l'occiput.

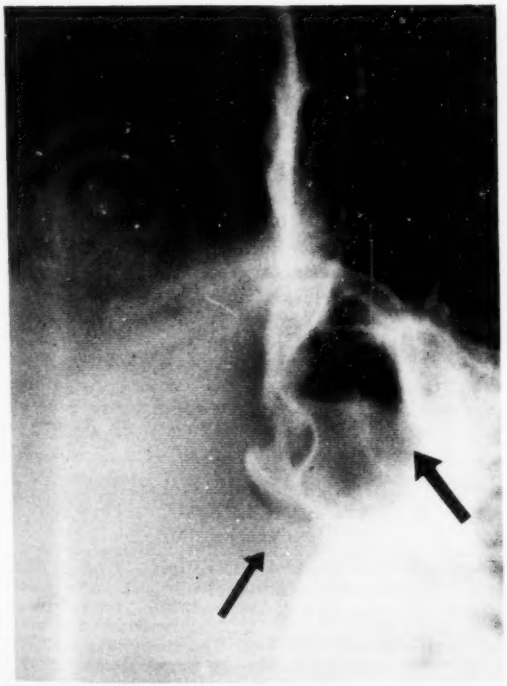

Figure III — Niveau liquide et pneumocéphalie chez un malade avec fracture de l'occiput.

Figure V — Niveau liquide avec fracture frontale enfoncée.

DESTRUCTIVE LESIONS OF THE CLAVICLE †

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Introduction

The purpose of this paper is to classify and review destructive lesions of the clavicle in the light of personal experience and the available literature. The published information is scanty and in direct proportion with the rarity of these lesions. One can only speculate as to why these lesions are rare. The structure of the clavicle is such that it contains no medullary canal and only little red marrow. The blood supply is comparatively poor. These facts could account for lower incidence of metastatic tumors and hematogenous bacterial infections. The proportionally high amount of compact bone may explain the rarity of involvement in metabolic bone diseases. Although the lesions are rare, almost all morbid processes that can occur in bone have been sporadically reported in the clavicle. From the clinical point of view, all clavicular lesions have one common denominator: swelling, with or without pain. The following table summarizes the destructive lesions of the clavicle:

SUMMARY OF DESTRUCTIVE LESIONS OF THE CLAVICLE

I Diseases Affecting Primarily the Joints:

1. Rheumatoid arthritis and rheumatic fever[15,33,46*].
2. Monarticular non-infectious, sub-acute arthritis of the sternoclavicular joint[5,8*].
3. Tuberculous arthritis[15*].
4. Gout[46*].
5. Degenerative osteoarthritis[15,31*].
6. Miscellaneous group: infectious synovitis; ankylosing spondylitis; gonococcal arthritis; syphilitic arthropathy[8,15,46]; destructive acromioclavicular arthropathy in primary and secondary hyperparathyroidism[37,38].

II Diseases Affecting Primarily the Bone:

A) *Vascular Disturbances:*
1. Aseptic necrosis of the medial end[16].
2. Aseptic necrosis of the lateral end[6,11,12,22,47].
3. Massive osteolysis (disappearing bone, phantom bone, angiomatosis)[19,26,36].
4. Erosion of the clavicle by aortic aneurysm[23].

B) *Inflammatory Processes in or about the Clavicle:*
1. Suppurative osteomyelitis[23,28*].
2. Non-supportive Periostitis and osteomyelitis[1,7,23,44].
3. Blastomycosis*.
4. Echinococcus[23].
5. Tuberculosis[30,40].

C) *Histocytosis and Pseudo-Tumoral Lesions:*
1. Eosinophilic granuloma[10,14,23,34,39].
2. Hand-Schuller-Christian disease[20].
3. Bone cyst[1,17].

D) *Tumors:*
1. Benign —
   a) Chondroblastoma[1].
   b) Enchondroma[42].
   c) Juxtacortical chondroma.
   d) Aneurysmal bone cyst[24,39].
   e) Hemangioma[24,48].
   f) Giant cell tumor[1,17,23].
2. Malignant —
   a) Chondrosarcoma and myxochondrosarcoma[2,9].
   b) Fibrosarcoma[29].
   c) Osteogenic sarcoma[1,39].
   d) Ewing's tumor[1,3,17,23,39,41].
   e) Multiple myeloma[1,13,17,23,24,29].
   f) Lymphomas:
      1. Chronic lymphatic leukemia*.
      2. Hodgkins disease.
      3. Lymphosarcoma*.
   g) Metastatic Tumors:
      1. Breast[1,17,41*].
      2. Prostate[23].
      3. Ovary[23].
      4. Kidney[23*].
      5. Bronchus[23*].
      6. Malignant melanoma[1].
      7. Adenoid cystic carcinoma[1].
      8. Undetermined*.

E) *Miscellaneous Group:*
1. Acroosteolysis[21].
2. Syringomyelia[43].
3. Scleroderma[35].
4. Looser-Milkman syndrome[23].
5. Undetermined.

*see Case history and illustration.

† *Presented in part at the Annual Meeting of the Canadian Association of Radiologists, on January 23, 1961, Saint John, New Brunswick.*

Rheumatoid Arthritis

Destructive bone lesions associated with rheumatoid arthritis were reported as early as 1913 by Pierre Marie and Leri[32]. Sternoclavicular involvement was recorded in the literature[15,33,46] but acromioclavicular lesions have not been reported to our knowledge.

CASE I

This 47-year-old female was known to have advanced rheumatoid arthritis, confirmed by laboratory findings and roentgenologic skeletal survey. Films showed the acromioclavicular joints to be grossly intact. Four years later, symmetrical destructive lesions of the acromial articulation became manifest (Figure 1). The laboratory tests disclosed anemia. The serum calcium, phosphorus and alkaline phosphatase were normal. The latex fixation test was strongly positive. There were also eosinophilia and positive L.E. phenomenon, which four years previously was negative, and hypoalbuminemia and hypergammaglobulimenia.

Figure 1, Case I — P.A. film of chest. Rheumatoid arthritis. Bilateral symmetrical osteolytic lesions of the lateral ends of clavicles.

Comment. Although no biopsy confirmation is available, in view of active and advanced rheumatoid lesions elsewhere, it seems reasonable to assume that this case falls into the category under consideration.

Monarticular Non-Infectious Arthritis of the Sternoclavicular Joint

Attention has been recently drawn to this form of destructive arthritis[5,8] involving only women past forty years of age who are performing strenuous physical activities. The lesions occur on the dominant side, i.e. on the right in those right-handed and vice-versa. Pathologically the lesions resemble rheumatoid arthritis. The joint space is filled with sterile fluid. Villi originating from synovia and pannus erode articular surfaces. Aggregates of lymphocytes are present. However, the Rose-Waller agglutination test is negative, the E.S.R. is normal, and no other joints are involved. The disease is self-limited and subsides without treatment.

CASE II

A 43-year-old right-handed woman was discovered to have swelling of her right sternoclavicular joint when examined by her doctor for an unrelated illness. Oblique and frontal roentgenograms failed to demonstrate the lesion. It was apparent only on tomograms (Figure 2). There is irregular scalloping of the sternal articular surface bordered by reactive sclerosis. Similar lesions, although to a lesser degree, are present on the clavicular articular surface. The joint space is irregular and slightly widened. The Wassermann reaction, blood morphology, E.S.R. and serum uric acid were all normal.

Figure 2, Case II — Frontal tomogram of the sternoclavicular joints, showing right sided monarticular, noninfectious, subacute arthritis. The right sternal articular surface is scalloped and eroded with subchondral sclerosis. Similar, less pronounced changes are noted on the clavicular articular surface. The articular space is narrowed. Compare with the normal left sternoclavicular joint.

Tuberculous Arthritis of the Acromioclavicular Joint

Tuberculosis involving the clavicle, either shaft or joints, has been recorded in the literature[15,30,40].

CASE III

A 77-year-old female had suffered for a few months from a painful swelling of the right acromioclavicular joint. A chest film disclosed parenchymal

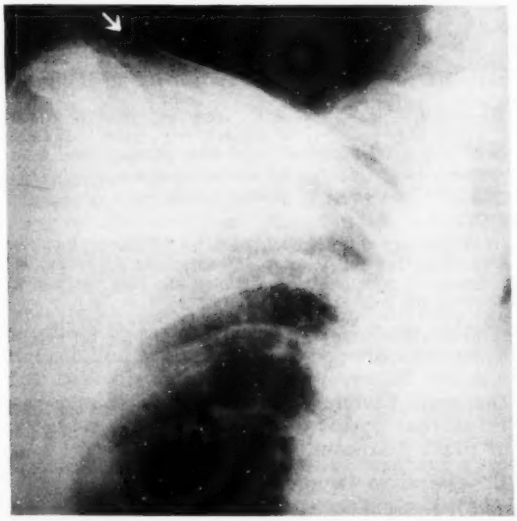

Figure 3, Case III — P.A. view of chest and right shoulder. Tuberculous arthritis. Erosion of the acromial end of the clavicle. Note the pulmonary infiltration.

infiltrations. Films of the involved joint showed destruction of the articular surfaces extending to the lateral end of the shaft (Figure 3). The lesion was excised and the pathological examination disclosed tuberculous arthritis; this was suspected clinically because of the association of lung and articular lesions. A few months later the patient died from disseminated tuberculosis.

Gout

The occurrence of gout in sternoclavicular joints was mentioned by Sokoloff and Gleason[46]. The following two cases are believed to belong to this type of arthritis. Both occurred in middle-aged men and both involved the dominant acromioclavicular joint, i.e. the right one in a right-handed and the left one in a left-handed man. Both were manifested clinically by painful swelling, and in both, the serum uric acid levels were elevated (8 mgm. %) and all other laboratory tests were normal.

CASE IV

A 55-year-old man whose shoulder film (Figure 4) shows reduction in width of the articular space, erosion of the surfaces with slight eburnation and tiny punched-out bony defect in the clavicle. No significant osteoporosis is present.

Figure 4, Case IV — A.P. view of right acromioclavicular joint, in a patient with gout. Erosion of the articular surfaces with subchondral sclerosis, and widening of the joint space.

CASE V

A 48-year-old man whose film (Figure 5) shows irregular fraying of adjacent articular surfaces and absence of osteoporosis. Films made two years later showed no appreciable change.

Comment. In both these cases of gout the symptoms were not incapacitating and did not warrant biopsy. The elevated uric acid and the small punched-out bony defects make us think that both cases belong to the category of urate diatheses.

Degenerative Osteoarthritis

Degenerative osteoarthritis in the clavicular joints is quite common. Autopsy studies conducted by Langen[31] led him to the belief that in the sternoclavicular joints the degenerative changes start in the age group of twenty-five to thirty years, and by seventy years of age involve 100% of patients. The disease is usually asymptomatic but occasionally may be associated with pain necessitating resection of the involved bone[15]. Pathologically there is fibrillation and fraying of the cartilage, erosion and cystic degeneration of subchondral bone, and productive changes evidenced by sclerosis and osteophytosis. Radiologically the lesions are manifested by lipping of the surfaces, which are regular in outline. The space is usually narrowed.

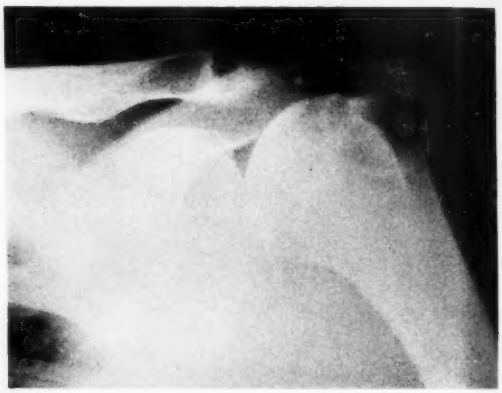

Figure 5, Case V — A.P. view of left acromioclavicular joint. Gout. Roentgen findings similar to Figure 4.

CASE VI

An asymptomatic lesion (Figure 6) found on a routine radiogram of the chest of a 70-year-old female.

Figure 6, Case VI — P.A. view of the right acromioclavicular joint. Degenerative ostearthritis. Narrowing of the articular space; erosion and lipping of the articular surfaces.

Undetermined

CASE VII

A 58-year-old laborer employed in a railway workshop complained of pain localized to the level of the humeral insertion of the right deltoid muscle.

The films (Figure 7) failed to reveal any abnormality at the indicated painful spot, but the acromioclavicular joint showed fine erosions of both articular surfaces with some subchondral bony sclerosis and thinning of the articular space. Similar changes, although much less evident, were noted on the opposite side. The laboratory findings were not revealing.

Figure 7, Case VII — A.P. view of right acromioclavicular joint. Degenerative osteoarthritis?

Comment. This could well be a case of degenerative osteoarthritis, but we prefer to leave it unlabelled until more knowledge is gathered.

CASE VIII

A 41-year-old laborer in an aircraft factory with a tender and swollen left sternoclavicular joint was first seen two years ago. The films showed widening of the medial end of the clavicle with increased density of bone. The articular surface was irregular and notched. Two years later, the roentgenograms (Figure 8) showed no change in the status of the involved joint. The tenderness subsided completely; the lesion was not incapacitating. The Wassermann reaction was negative. A needle biopsy was attempted but it produced only tiny particles of normal-appearing cartilage, so this problem remains unsolved.

Figure 8, Case VIII — Frontal tomogram of the left sternoclavicular joint. Increased bony density of the medial end of the left clavicle, with scalloping and irregularity of articular surfaces.

Comment. The response of joint tissues to pathogenetic agents shows little gross variation and therefore the radiologic patterns are often non-specific. Thus the final diagnosis requires correlation with laboratory findings.

Hyperparathyroidism

Destructive acromioclavicular arthropathy occurring in cases of primary and secondary hyperparathyroidism was described by Nathanson and Slobodkin[37] who observed it in three patients. Another case is shown in the textbook by Paul and Juhl[38]. Nathanson and Slobodkin believe that the arthropathy, manifested radiologically by fraying and cupping of articular surfaces, is characteristic of the disease.

Aseptic Necrosis of the Medial or Epiphyseal End of the Clavicle

This condition was first reported by Friedrich[16] who observed it in two patients in which the lesion was manifested by loss of bony substance and alteration of density.

Aseptic Necrosis of the Lateral End of Clavicle

Evans'[12] first report was in 1951. His study was based on four cases, all of which occurred in young men following trauma. In three of these cases there was bulbous enlargement of the lateral end of the clavicle with degenerative changes involving the articular cartilage. In the fourth case, there was absorption of the lateral end of the bone. The case reported by Chatton and Pellisier[6] concerns a 7-year-old boy in whom the lesion was roentgenologically manifested by fragmentation of bone and alteration of density. Conservative management provided complete recovery in three years. Ehricht[11] reported one histologically-proved case as an occupational hazard. Hasselmann[22] questioned the traumatic factor in the etiology of clavicular osteolysis. Viehweger[47] believes that the process is the result of damage to the brachial plexus with subsequent trophic changes in the bone or interference with nutrition due to vascular occlusion. Schroth[43], on the other hand, thinks that the localized so-called "post-traumatic" osteolysis of the clavicle is a manifestation of a latent syringonyelia.

Massive Osteolysis

In recent years attention has been drawn to an entity called variably "massive osteolysis", "disappearing bone" or "phantom bone." The disease is triggered by trauma, usually trivial. The manifestations may sometimes be as late as five years after the accident. The disease is usually progressive and may involve more than one bone. Clinically

there is pain and some impairment of movements. No neurological abnormalities are found, and blood chemistry, including serum calcium, phosphorus, phosphatase and protein, remains normal. The radiologic features consist of gradual disappearance of the shadow of the involved bone. Cases involving the shoulder joint, including the lateral segment of the clavicle, were reported by Jones et al[26] and Milner and Baker[36]. The pathology of this disease was discussed by Gorham and Stout[19] who believe hamangio- or lymphangiomatosis to be responsible for the osteolysis.

Erosion of the Clavicle by Aneurysm of Aorta

This condition was reported by Grashey[23].

Suppurative Acute and Chronic Osteomyelitis[23,28]

In 80% of the cases this is caused by Staphylococcus aureus from a local or distant focus. Clinically the disease is manifested by cardinal signs of infection. Roentgenologically the clavicle shows loss of definition of cancellous bone, patchy decalcification and destruction. If the process of repair sets in, new bone formation will take place. Figure 9 shows a case of subacute osteomyelitis of the right clavicle following open reduction of a fracture, followed by regional cellulitis (Case IX).

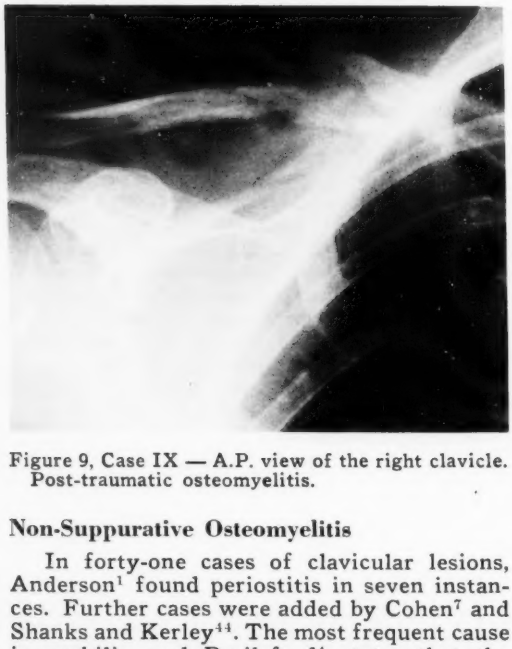

Figure 9, Case IX — A.P. view of the right clavicle. Post-traumatic osteomyelitis.

Non-Suppurative Osteomyelitis

In forty-one cases of clavicular lesions, Anderson[1] found periostitis in seven instances. Further cases were added by Cohen[7] and Shanks and Kerley[44]. The most frequent cause is syphilis, and Brailsford[4] states that the clavicle is the commonest site of luetic bony lesions. The process may be sclerosing, ossifying, osteoporotic or destructive[7].

Blastomycotic Abscess

CASE X

A 28-year-old white male was admitted to St. Mary's Hospital for pain and swelling of the medial end of the right clavicle of two weeks duration. The patient stated that he had had similar symptoms twelve years earlier. Except for localized enlargement of the clavicle, the physical examination was non-contributory. Chest films and Wassermann reaction were both negative. The tomogram (Figure 10) showed slight enlargement of the medial end of the clavicle. A central oval-shaped defect surrounded by bone of increased density indicates the abscess. The lesion was saucerized and the microscopic study of the obtained material disclosed granulomatous inflammation and budding yeast-like bodies identified as blastomyces.

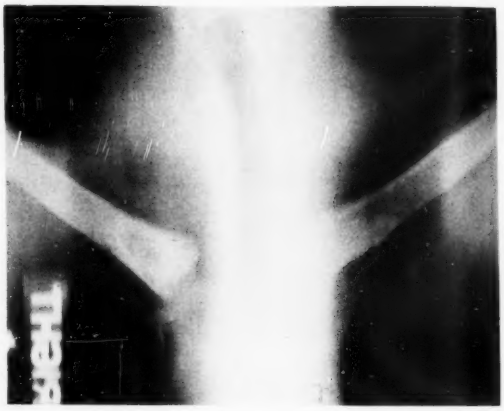

Figure 10, Case X — Frontal tomogram of the right clavicle. Blastomycotic abscess, shown by a central elliptic defect surrounded by sclerotic bone.

Eosinophilic Granuloma

Eosinophilic granuloma is a benign histiocytosis related pathologically to Hand-Schuller-Christian and Letterer-Siwe diseases. In twenty-eight cases of eosinophilic granuloma recorded by McGavran and Spady[34], one was localized to the clavicle. Other clavicular localizations were reported by Dundon et al[10], Fevre[14], Oberdalhof[23] and Pratt et al[39]. The lesion produces localized enlargement of the bone with a central elliptic defect. The defect is bordered by a dense margin in continuity with the cortical layer of normal bone. This fork-like appearance is quite characteristic of the lesion [14]. Hand-Schuller-Christian disease with multiple bony involvements, including the clavicle, was recently reported by Green and Flaherty[20].

Bone Cysts

Bone cysts of the clavicle appear roentgenologically as cystic expansion of the bone, producing thinning of the cortex. Four cases were reported by Anderson[1] of which three were located at the sternal end, and one had multiple cavities in the acromial end of the bone. One of two cases reported by Geschichter and Copeland[17] was complicated by a pathological fracture.

Chondroblastoma

One case without pathological verification was reported by Anderson[1].

Enchondroma

This lesion appears as a cyst-like defect bordered by a thin sclerotic margin. Pathological fractures may occur[42]. Cases of juxtacortical chondroma were described by Jaffe[24]. One case with clavicular localization was recently seen by the author. The differentiation from periosteal desmoid[27], fibrous cortical defects and xanthoma is difficult and usually cannot be made without pathological examination.

Aneurysmal Bone Cyst

The term "aneurysmal bone cyst" was introduced by Jaffe. It refers to a benign lesion producing an eccentric subperiosteal ballooning of the bone. The outer contour of the aneurysmal bone cyst is sharp and regular. A thin sclerotic layer separates the lesion from adjacent normal bone. The usual location is in the ends of long tubular bones. Occasionally the cyst may occur in the clavicle[24,39].

Hemangioma

The classical sites of this benign vascular tumor are vertebrae and calvarium. Exceptionally it may be located in the clavicle[24] and a well-illustrated example was reported by Zsebok[48]. In his case, the tumor produced a typical sun-ray pattern in the lateral half of the clavicle.

Giant-Cell Tumors

These tumors in the clavicle[1,17,23,45] produce, as in other locations, a soap-bubble pattern, occasionally complicated by pathologic fracture[45].

Chondrosarcoma and Myxochondrosarcoma

Chondrosarcomas occur in clavicles in less than 2.5%[9]. In the series reported by Pratt et al[39], there were five cases in twenty-three malignant tumors. Becker[2] reported one case of myxochondrosarcoma in a 15-year-old boy. The tumors invade and destroy a major part of, or the entire bone.

Osteogenic Sarcoma

Osteogenic sarcoma of osteolytic or sclerosing variety may occasionally be found in the clavicle[1,39].

Ewing's Tumors

These occur in the clavicle more frequently. Anderson[1] found four cases in forty-one clavicular lesions. Pratt et al[39] counted six in a total of twenty-three malignant clavicular lesions. Other cases were reported by Geschichter and Copeland[17], Schinz et al[41], Rose and Banerjee[3] and Hohmann and Parhofer[23]. Roentgenologically the appearance of Ewing's sarcoma is quite typical. The tumor causes some expansion of the bone. The lesion is mixed in type, with areas of destruction of the cortical and cancellous substance and periosteal reaction of either the "onion skin" type or spur formation.

Multiple Myeloma

Clavicular localization of myeloma was mentioned by Jaffe[24]. The series of Anderson[1] includes eight cases, Pratt's[39] nine cases. Other cases were reported by Latinek[23], Krainin et al[29], Geschichter and Copeland[17], and Ferrand and Paquello[13]. In the latter the lesion was bi-polar, having involved both ends of the bone. From the roentgenologic point of view, the lesion is purely osteolytic in type. The bone is usually slightly expanded and shows either a "moth-eaten" pattern or punched-out rounded defects.

Malignant Lymphomas

The involvement of bones in lymphomas results from direct invasion from adjacent lymph nodes or blood-borne metastases. The bones are quite frequently affected in acute leukemias of children and in the late stages of the disease in adults. Whether primary involvement of bone exists is still a matter of controversy, but it is certain that it can be the presenting symptom of the disease (Case XIV).

Chronic Lymphatic Leukemia

CASE XI

A 59-year-old white female was admitted to St. Mary's Hospital for an infected wound of one finger. The physical examination at that time disclosed generalized lymph node enlargement and the blood morphology showed a typical picture of lymphatic leukemia. The patient was discharged from hospital and treated by cytotoxic agents. She was readmitted three years later due to gradual deterioration of her condition. On admission generalized lymph node enlargement was again noted,

Figure 11, Case XI — Frontal tomogram of the medial end of the left clavicle. Chronic lymphatic leukemia, complicated by pathological fracture.

without splenomegaly. The blood studies were typical of leukemia with moderate anemia. During her stay in hospital, the patient experienced sudden pain on elevation of her arm. The films disclosed irregular destruction lesions in each clavicle, with thinning of the cortex, and a pathological fracture at the medial end of the left clavicle (Figure 11). Shortly after, she expired and the autopsy confirmed the diagnosis.

Hodgkin's Disease

The incidence of bony involvement varies according to reported statistics from 15.7% to 78%[24]. The clavicles are involved in about 3.5% of bony lymphogranulomatous lesions. The lesions are usually purely osteolytic, although rarely sclerosis and periosteal bone formation may be seen[41]. Among other bony metastases, the clavicles show destructive lesions, without reactive sclerosis or periosteal reaction.

Lymphosarcoma

Lymphosarcoma in bones is less frequent than Hodgkin's disease and occurs in about 10%[14]. The skeletal lesions are usually late manifestations of the disease.

CASE XII

This case is interesting in that the clavicular lesion was the first clinical manifestation which attracted the patient's attention. He was a 42-year-old white male complaining of pain and swelling in the left clavicle. The X-ray film revealed extensive bony destruction of the lateral half of the clavicle. The biopsy showed lymphosarcoma. The lesion responded well to Co^{60} therapy (Figure 12). A few months later abdominal pains brought the patient to St. Mary's Hospital. Laparotomy showed large masses involving lymph nodes and alimentary tract. The diagnosis of lymphosarcoma was again confirmed by pathological examination.

Figure 12, Case XII — A.P. view of the left clavicle, following Co^{60} therapy for lymphosarcoma.

Metastasis

Metastases constitute the largest group of destructive lesions of clavicles. By and large most cases are caused by tumors originating in breast[1,17,41], kidney, prostate[23] and bronchus, but occasionally have resulted from a primary in the salivary gland, malignant melanoma in skin[1] or ovary[23].

CASE XIII

A 47-year-old female first showed clavicular metastasis (Figure 13) which occurred six months after radical mastectomy.

Figure 13, Case XIII — A.P. view of the right clavicle. Metastasis from breast carcinoma.

CASE XIV

A middle-aged white female complained of painful swelling of right clavicle. Biopsy revealed metastic carcinoma consistent with the primary lesion in the kidney. This diagnosis was subsequently confirmed by excretory urogram.

Figure 14, Case XIV — A.P. view of the right clavicle. Pathological fracture in metastasis from kidney.

CASE XV

A 48-year-old white male was referred to the Radiology Department of St. Mary's Hospital because of asymmetry of the clavicles, the left one being more prominent and tender. The lateral roentgenogram (Figure 15) shows destruction of the medial one-third of the left clavicle. The lesion was excised; its secondary nature was established by the pathologist. Further investigations related the metastasis to a bronchogenic carcinoma, which was otherwise clinically silent.

Acro-Osteolysis

In 1949 Harnasch[21] described acro-osteolysis, an entity which was manifested by lysis of terminal phalanges of fingers and toes,

alveolar edge of maxilla and lateral end of clavicle. The author attributed the lesions to imbalance in the sympathetic and parasympathetic nervous systems caused by hypofunction of the eosinophilic cells of the hypophysis. Giaccai[18], on the contrary, thinks that acro-osteolysis is due to lesions of peripheral nerves.

Figure 15, Case XV — Lateral tangential view of the left clavicle. Destruction of the medial part by metastasis from bronchogenic carcinoma.

Scleroderma

Absorptive changes in the clavicle occurring in scleroderma were reported by Meszaros[35].

Syringomyelia

Syringomyelia is capable of producing osteolytic lesions in the clavicles, according to Schroth[43] who thinks that "formes frustes" of the disease are responsible for some cases of so-called post-traumatic osteolysis.

Conclusion

A patient with clinical symptoms, or signs suggesting a lesion in the clavicle or its joints, presents to the radiologist a double problem, technical and diagnostic.

For the lateral part of the bone, frontal views usually suffice. We have, however, seen cases where standard A.P. or P.A. views failed to demonstrate the lesion which was easily seen on chest roentgenograms. This proves that in some cases various projections may be necessary to demonstrate the lesion. For the lesions medially located, the frontal and oblique views are almost useless and tomograms should be made. In exceptional cases, only tangential lateral projections will bring the lesion to light. It is advisable to make films of the opposite side for comparison.

Once a lesion has been demonstrated, the problem of benign versus malignant lesion faces the radiologist. The distinction can usually be made using the same criteria as for other bones. A definite diagnosis may require extensive laboratory tests, and often biopsy.

Summary

1. A classification of destructive lesions of the clavicle is presented from the literature and our cases.

2. A destructive lesion in the clavicle may, in some cases, be the first clinical manifestation of a distant serious disease.

3. Technical and diagnostic problems are briefly discussed.

Résumé

1. L'auteur présente une classification des lésions destructives de la clavicule, en se basant sur la littérature et sur son expérience.

2. Une lésion ostéolytique de la clavicule peut parfois correspondre à la première manifestation clinique d'une importante maladie à distance.

3. Une brève discussion porte sur les problèmes techniques et diagnostiques.

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PERCUTANEOUS TRANSFEMORAL AORTOGRAPHY IN THE INVESTIGATION OF HYPERTENSION OF RENAL ORIGIN *

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The demonstration by Goldblatt[5] of the potential part played by narrowing of the renal artery in the etiology of hypertension opened up a vast new field in the investigation and treatment of this disease. Since then, many methods, mostly biochemical, have been devised to measure various aspects of renal function which have been regarded as dependent upon maintenance of normal blood supply. Some of these, such as that of Howard and Etamon (TEAC)[1,7] have proven to be of considerable diagnostic value, but have suffered somewhat from inconsistent results. Within the past decade the problem has been attacked more directly by many workers by contrast visualization of the renal arteries.

In most of the reported series, visualization of the renal arterial system has been via the translumbar route. In our institution, translumbar aortography has not yielded consistently satisfactory visualization of the renal arteries. Because of this, and the potential hazards of this approach, we have adopted the method of catheterization of the femoral artery.

Several methods of transfemoral catheterization of the aorta have been described, some employing exposure of the artery, and others by percutaneous puncture. In our experience, the most satisfactory method to date is that described by Seldinger[15,16] in 1953. It is basically his method that we employ.

During the past twenty months since 1959, we have performed more than 75 renal angiograms by the percutaneous femoral route. The majority of these have been in patients in whom a renal origin of hypertension was suspected. A few cases had established unilateral chronic pyelonephritis; here the examination was done not only to confirm the clinical diagnosis but also to establish the presence of a normal renal arterial supply to the contralateral kidney.

Seldinger Technique (Figure 1)

Following local or general anesthesia, the femoral artery is punctured percutaneously, the stilette withdrawn and a thin metal leader with a flexible tip inserted through the needle into the arterial lumen. If any resistance is encountered the puncture is not satisfactory, even though a free arterial flow through the needle has been obtained.

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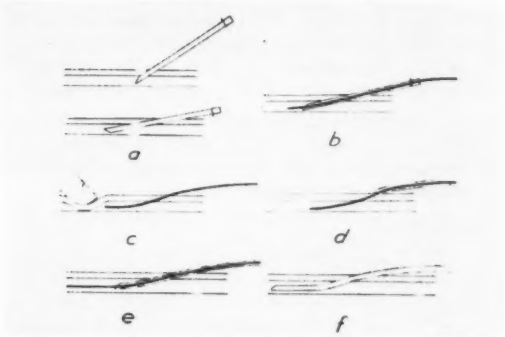


Figure 1 — Diagram of the technique used (after Seldinger). a) The artery punctured. The needle pushed upwards. b) The leader inserted. c) The needle withdrawn and the artery compressed. d) The catheter threaded on to the leader. e) The catheter inserted into the artery. f) The leader withdrawn.

After the leader is inserted a few inches, the needle is withdrawn over the leader and pressure exerted over the artery proximally. The end-hole catheter (per Odman PE-160), which has four side-holes in its distal 4 cm., is threaded over the leader until its tip reaches the skin. At this point the free end of the leader must protrude from the catheter. The catheter is then threaded into the artery and the leader withdrawn. After the catheter is passed to the anticipated level, its position is checked fluoroscopically or radiographically. Since minor adjustments in position are frequently necessary, we have adopted the use of a polaroid film apparatus to permit rapid viewing. We feel the optimum position for the catheter tip to be such that the last catheter side-hole lies half an inch above the expected level of the renal arteries, almost always at L1-L2; otherwise unequal arterial and parenchymal opacification may occur. A test dose of 2 cc. of opaque medium is usually given immediately before the test

* *Presented at the Annual Meeting, The Canadian Association of Radiologists, January 24, 1961.*

exposure. This will detect the remote possibility of a subintimal position of the catheter tip, as well as revealing patient sensitivity to the medium.

Twenty to 30 cc. of opaque medium is then rapidly injected, using a compressed air injector at a pressure of 7 to 10 kilograms per sq. cm. Serial films are made at half-second intervals for four seconds, starting with the initiation of the injection. Following this, exposures are made at 10-second intervals up to 30 seconds. Reactions to the injection have been slight or entirely absent.

Although we have done a number of selective renal artery catheterizations, we reserve this refinement for the infrequent case in which good bilateral artery visualization has not been obtained. We have also employed cinefluorography in conjunction with selective visualization. The latter procedure has been abandoned because detail with 16 mm. cine film is not comparable to that obtained with radiographs using a rapid film changer.

In addition to the advantages of superior visualization and relative lack of hazard, this technique does not result in any radiation exposure to personnel.

Indications

The indications for renal arteriography in hypertensives have been well documented in the past, on this continent chiefly by Poutasse[3,14] and his co-workers. Their methods of selection are widely accepted, and are as follows:

1. Patients in whom there is disparity in size or excretory function of the two kidneys, as shown on the intravenous urogram. However, the urogram may be normal in the presence of obstructive lesions. A difference of 1 cm. or more in the length of the kidneys may be significant.
2. Young patients without family history of hypertension.
3. Middle-aged or elderly hypertensive patients who suddenly develop malignant hypertension.
4. Those hypertensives of any age with long-standing hypertension which abruptly becomes severe.
5. Malignant hypertension arising without a preliminary period of essential hypertension.

Recently we have come to regard a positive Etamon test as a further indication.

Contraindications

Contraindications would include those patients in whom severe bilateral renal disease is clinically suspected, as well as those with hemorrhagic diathesis. Atherosclerosis and tortuosity of the iliac vessels, while not in themselves contraindications, may render it impossible to pass the catheter to the desired level in the aorta.

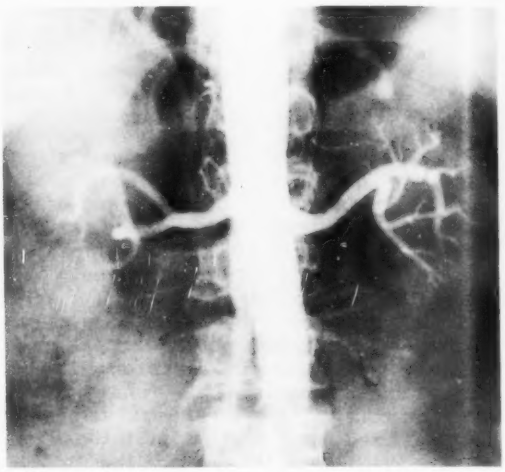


Figure 2 — A 44-year-old male with malignant hypertension. Normal main renal arteries.

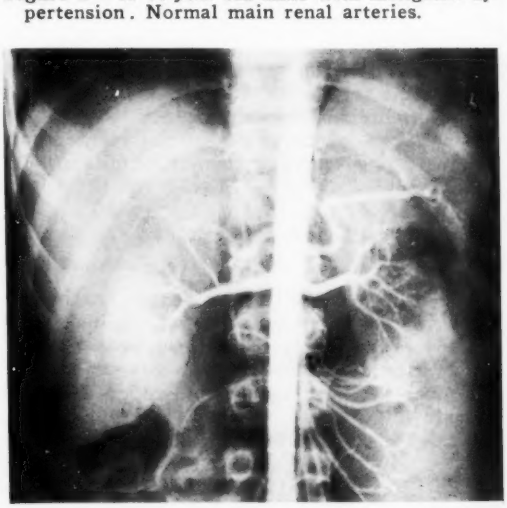


Figure 3 — The renal arteriogram of an 11-year-old boy showing normal renal arteries and the usual distribution of the interlobar arterial tree.

Complications

Complications in the reported series are few, and include those of any injection of opaque media. Hemorrhage at the puncture site has been reported. We have found this to be infrequent and easily controlled by manual pressure. In two patients hematomas of moderate size occurred. In our series subintimal injection has occurred twice without consequence. This hazard should be avoided by adherence to the technique previously described. We have not had any renal complications.

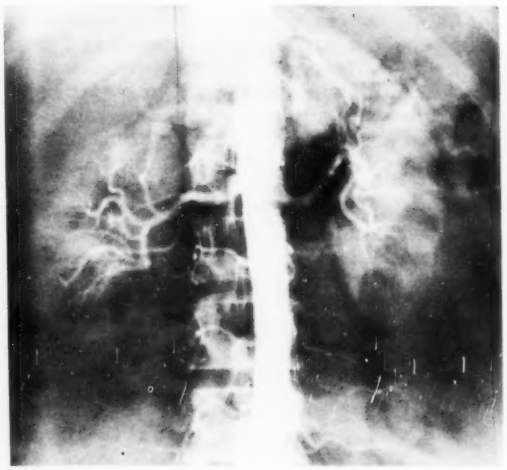


Figure 4 — A female, 40 years of age, who had been hypertensive since her late teens. Minimal right renal artery orifice stenosis and post-stenotic dilatation. The Etamon test was positive; the Howard test indicated deficient vascularity of the right kidney. At operation, the right renal artery was small; revascularization was not feasible and the right kidney was removed. Following nephrectomy, the patient, previously resistant to antihypertensive therapy, responded. The patient has now been normotensive for 18 months, lately without any medication.

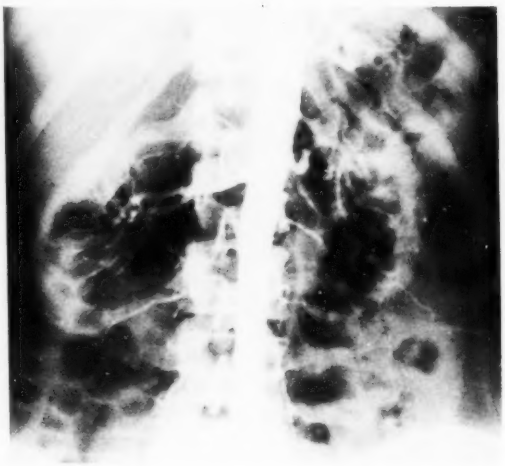


Figure 5 — A female, 35 years of age, with severe hypertension.
Note a band-like narrowing of the left renal artery, just beyond its orifice, with a slight degree of post-stenotic dilatation. *Also note* relative smallness of the left kidney, with a somewhat irregular contour and a decreased left nephrogram. At exploration, the left renal artery was smaller than average and a palpable thrill was present. On dissecting out the left renal artery the thrill disappeared and arterial pulsation improved. The surgeons felt that the colour of the renal tissue improved and that the renal vein then filled up. Because of the small size of the left renal artery, an anastomosis between the splenic and renal arteries was done.

Analysis of Material

In this series of 72 renal angiograms, 53 were of patients with hypertension of suspected renal origin. Fourteen had suspected renal expanding lesions, 2 unexplained hematuria, and the others suspected aortic aneurysms or congenital absence of a kidney.

In this group of 72 patients there were 9 failures; 5 of these failures were related to tortuosity and atherosclerosis of the iliac vessels. Two were the result of inadequate arterial puncture, while 2 others were unsuccessful because of partial subintimal injection. With our further experience it is not anticipated that these two latter causes of failure will recur.

Of the 63 successful examinations, equal and adequate visualization was obtained in 48.

In 12 cases, one artery visualized better than the other, but both were adequate for assessment.

In only 3 out of the 63 cases was visualization of one or other artery inadequate. These cases of unequal or inadequate visualization are considered to be due to improper positioning of the tip of the catheter, although occasionally the orifice of a renal artery is obscured by the superior mesenteric artery.

In the interpretation of angiograms of a patient with hypertension and suspected renal vascular lesions, the following features should be searched for:

A. *Arterial phase:*
   (1) Absence of the normal funneling appearance of the renal artery at its origin.
   (2) Obstruction of the renal artery or one of its primary branches.
   (3) Atheromatous plaques at the orifice of the artery.
   (4) Renal artery stenosis with or without post-stenotic dilatation.
   (5) Localized or diffuse irregularity of the lumen, suggesting atherosclerosis.
   (6) Distortion of the renal artery by aneurysms, adhesive bands, tumours, etc.
   (7) Absence or paucity of interlobar and interlobular arteries.

B. *Nephrographic phase:*
   (1) Unequal nephrographic density on the two sides.
   (2) Inequality of renal size.
   (3) Irregularity of renal contour.
   (4) Localized nephrographic defect.
   (5) Parenchymal thinning (absence or thinning of the cortical blush).

The cortical blush is seen in the peripheral portion of the nephrogram as a band-like zone of increased density of about 1 cm. in width. This represents, in part at least, loading of the tubular cells with contrast material, and probably filling of the interlobular cortical arteries in addition. A localized defect in this blush, or thinning of it, indicates thinning of the renal parenchyma associated with infarction or fibrosis.

Analysis of Hypertensives

Arterial phase: Fifty-three of our renal angiograms were performed on cases with hypertension of suspected renal origin. Unfortunately, 7 of our 9 failures fell into this group, leaving a total of 46 hypertensive patients with satisfactory angiographic studies (Table 1).

TABLE I

ANGIOGRAMS OF 46 HYPERTENSIVE PATIENTS
ARTERIAL PHASE

NORMAL	20	
ABNORMAL		
Constricting Lesions	13	— Unilateral 8
		Bilateral 5
Arterial Aneurysms	3	
Diffuse Atherosclerosis	3	
Pyelonephritis	5	
Uretero-Pelvic Compression	1	
Infarct	2	
Possible Aberrant Artery Obstruction	3	
Arterio-Venous Communication	1	

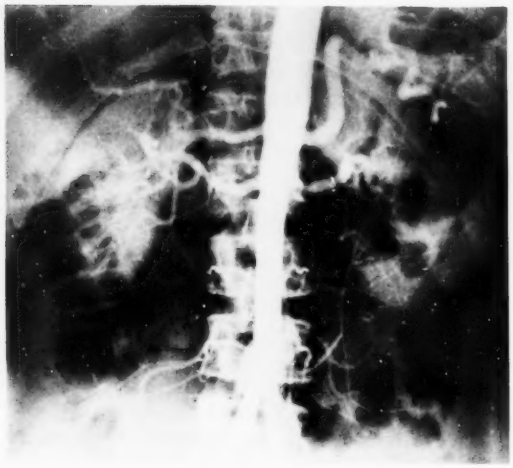
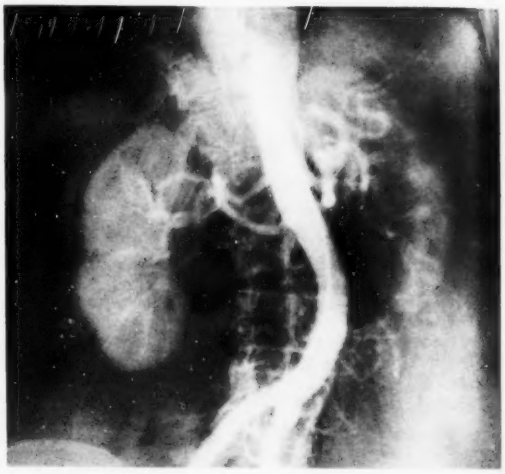


Figure 6 — A female, 41 years of age, with severe hypertension. The arteriographic phase shows clear-cut left renal artery stenosis and post-stenotic dilatation. The Etamon test was positive. At operation the arteriographic findings were confirmed, and a splenorenal arterial anastomosis was done.

Of the 13 constricting lesions demonstrated, 5 showed post-stenotic dilatation. Eleven of the 13 narrowings were interpreted as being due to atherosclerotic plaques, one to an adhesive band, and the other uncertain. One case, of particular interest, with a definite stenosis and marked post-stenotic aneurysmal dilatation of the main renal artery, showed multiple tiny interlobar artery aneurysms suggesting periarteritis nodosa (Figures 9A and 9B). This was the clinical diagnosis and was pathologically proven.



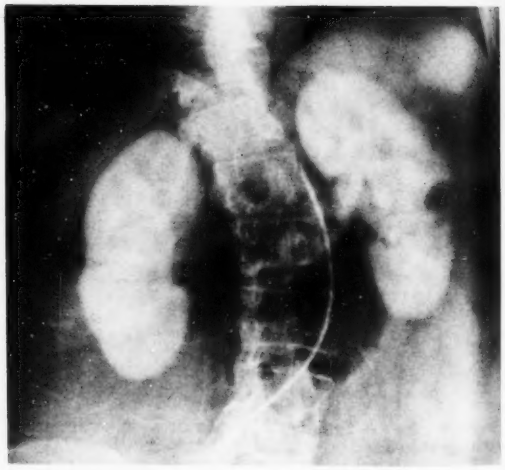


Figure 7 — A female, 61 years of age, with hypertension.

(a) The arterial phase, showing absence of the interlobar arteries in the central portion of the right kidney; there is an indentation of the cortex at this point.

(b) the nephrograph studies show loss of cortical blush at the central part of outer margin of the right kidney. This picture is considered typical of renal infarction.

Nephrographic phase: In general, nephrographic studies correlated well, showing the type of abnormality which would be expected from study of the arterial phase. There were occasional exceptions, such as one patient with a definite unilateral renal artery stenosis in which the nephrogram on the involved side was quite normal, the involved kidney being actually a little larger than the contralateral normal side (Figure 6). On occasion, nephrography reveals one or other renal density to be decreased without any corresponding arterial abnormality. We feel that in at least some of these cases the position of the catheter tip was too low, and that more of the opaque medium from one side-hole was directed into the contralateral artery.

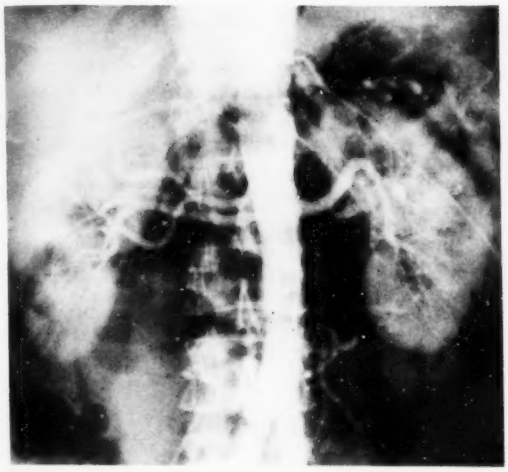


Figure 8 — A male, 63 years of age, who was admitted for investigation of painless hematuria, without hypertension. Renal aortography shows, as an incidental finding, orifice stenosis of the lower of the two right renal arteries.

Sixteen out of the 20 hypertensive patients with normal angiograms revealed a normal pyelogram. Three showed a relative smallness of all or a part of one kidney, probably a normal variation.

Of great interest is the fact that 12 and probably 13 of the 26 hypertensive patients with abnormal angiograms revealed no pyelographic abnormality. Even this small number of cases is quite suggestive that normal pyelographic studies in no way exclude the presence of renal artery abnormality.

Minor differences in renal size are occasionally seen in patients with otherwise normal pyelograms and with no history of hypertension. Thus, the significance of slight variations in renal size in hypertensives is difficult to assess. Nevertheless, in the hypertensive patient, slight differences in renal size, even of the order of 1 cm. or so, should be carefully looked for, as this may be the only indication of a unilateral renal vascular lesion. However, in our cases with renal artery abnormalities (26 in number) we have found only 10 which showed an obvious decrease in renal size. One patient, whose main renal artery was completely obstructed and whose total renal blood supply was through an aberrant artery of rather small size, showed an entirely normal excretory pyelogram (not illustrated).

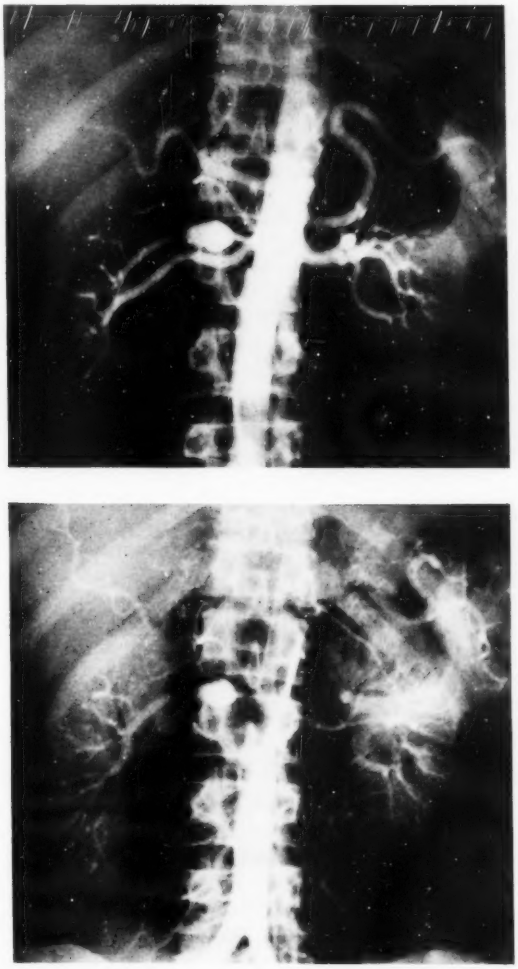


Figure 9 — A male, 32 years of age, with severe hypertension and a clinical and pathological diagnosis of periarteritis nodosa. Renal arteriography revealed (a) two right renal arteries, one of which is markedly stenosed at the orifice with an aneurysmal post-stenotic dilatation; (b) a slightly later film of the arterial phase, showing tiny intra-parenchymal interlobar artery aneurysms. At postmortem, opaque medium injection of the right kidney demonstrated clearly tiny intralobar artery aneurysms.

It is worthy of note that during investigation of patients suspected of having renal expanding lesions, 4 examples of localized stenotic vascular lesions were found. Three patients were normotensive, and the other only mildly hypertensive (140/90). We mention this only to point out that renal artery narrowings can be found in normotensive individuals, and arteriographic abnormalities must be interpreted with caution in the individual case, and in the light of other clinical and laboratory investigations.

Chronic pyelonephritis is frequently associated with hypertension[13]. The diagnosis can usually be made on the basis of clinical studies and excretory pyelography. However, aortography may be indicated in certain cases to establish the presence of a normal contralateral renal vasculature, as well as to confirm the diagnosis of chronic pyelonephritis. In this condition the main renal artery and its primary branches are usually normal in appearance. The interlobar arteries are typically sparse and irregularly reduced. The kidney may be reduced in size, often with an irregular outline. The nephrogram reveals numerous irregular radiolucencies, representing focal areas of fibrosis. Cortical defects and areas of parenchymal thinning are frequently visible. While the main renal arteries are frequently normal in size in atrophic pyelonephritis, it is worth pointing out that in cases of long-standing pyelonephritis, where one kidney is much contracted, the renal artery can become extremely small without any indication of tortuosity or other abnormality. Thus all small renal arteries are not hypoplastic.

Summary and Conclusions

1. Retrograde transfemoral aortography is a valuable procedure, simple to perform and relatively free of hazard to the patient. In the majority of cases a single injection results in satisfactory demonstration of the renal arteries.
2. In 46 hypertensive patients, arteriographic abnormalities were found in 26 - 56%.
3. Normal pyelographic findings do not exclude renal vascular disease.
4. We have, as yet, insufficient operative and/or clinical follow-up material to allow a reliable correlation with angiographic findings. However, we have the impression at this time that cases with clear-cut indications for revascularization procedures, or nephrectomy for the relief of hypertension, are not as frequent in our case material as reported elsewhere.
5. Attention is called to the fact that a relative degree of stenosis of a renal artery orifice may occur in patients who are non-hypertensive.

Résumé

1. L'aortographie rétrograde par voie fémorale s'avère une technique de valeur, d'une réalisation simple et relativement sans danger pour le patient. Dans la plupart des cas, une seule injection opacifie de manière satisfaisante les artères rénales.

2. Des anomalies artériographiques ont été notées chez 26 des 46 patients hypertendus ainsi examinés, i.e. 56%.

3. Une pyélographie normale n'exclut pas une maladie rénale vasculaire.

4. Jusqu'à date, une corrélation exacte des constatations angiographiques n'a pas été possible à cause du peu de pièces opératoires, combiné à l'insuffisance de l'évolution clinique. Toutefois, les auteurs ont actuellement l'impression que les cas chez qui ils ont trouvé des indications nettes pour les techniques de revascularisation ou la néphrectomie ne sont pas aussi nombreux que ceux que l'on rapporte ailleurs.

5. On souligne le fait qu'un certain degré de retrécissement de l'orifice d'une artère rénale peut exister chez des patients sans hypertension.

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TENTH INTERNATIONAL CONGRESS OF RADIOLOGY

Montreal - Canada

August 26th - September 1st

1962

The scientific programme for the Tenth International Congress of Radiology will include thirty symposia and thirty general sessions arranged in sequence developing discussions of the general subject matter which was announced in the Preliminary Programme issued in June 1961.

The titles for these symposia will be:

DIAGNOSTIC RADIOLOGY

Selective Angiography
- (a) Abdominal Aorta
- (b) Coronary Circulation
- (c) Cerebral Circulation

Renal Disease including Associated Systemic Changes
Cineradiography
Paediatric Radiology
Neuroradiology

THERAPEUTIC RADIOLOGY

Advances in Knowledge of Radiation Effects on Tissues of Vital Viscera in Humans
Clinical Cancer Therapy
Clinical Treatment Planning
Interstitial and Intracavitary Radiation Therapy
Clinical Results of High Energy Radiation Therapy
Metabolized Radioisotopes in Therapy

RADIATION PHYSICS

Concepts, Quantities and Units for Radiation Dosimetry
Physical Concepts in Dosimetry
Dosimetric Methods
Whole Body Counting and Scanning

RADIATION BIOLOGY

New Knowledge of the Cell and its Functions as derived by Autoradiography
Experimental Studies of Total Body Radiation, Marrow Transplantation
Toxicity and Dose Distribution of Internal Emitters and Chemical Protection against Radiation

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Dose in Diagnostic Procedures
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These will include a number of joint programmes devoted to special topics in which two or more of the general fields of diagnosis, treatment, physics and biology have interests in common.

Simultaneous translation in the four official languages will be provided for the symposia, which are being especially planned to cover developments during the last three years.

The papers proffered for the general sessions will be selected, insofar as possible, to form groups of common or related interest.

Radiologists, radiation physicists and radiobiologists who intend to attend the Congress, and especially those who wish to proffer scientific papers, scientific exhibits and scientific cine-films, are urged to complete the enrolment forms and other documents pertinent to such scientific communications at the earliest possible date — being reminded that the closing date for enrolment without additional fee and for proffer of titles and abstracts is 31st January 1962.

Although the Congress Secretariat has attempted to reach all medical radiologists, radiation physicists and radiobiologists, as well as other interested scientists who are known to various scientific societies around the world, and has issued over 17,000 copies of the Preliminary Programme, individuals who wish to attend and particularly those who desire to proffer such material but who have not received a Preliminary Programme with the appropriate forms, are invited to write to the Secretary-General, Tenth International Congress of Radiology, 1555 Summerhill Avenue, Suite 204, Montreal 25, Canada.

LÉSIONS GASTRO-INTESTINALES RÉVÉLÉES PAR LA RÉTENTION DE TÉLÉPAQUE*

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Il est d'observation commune, au cours d'un examen radiologique de la vésicule biliaire de retrouver du Télépaque non absorbé distribué dans la lumière colique.

Cependant, il arrive que le Télépaque demeure dans un autre segment du tube digestif. Cette rétention, pour être pourtant assez rare, prend toute sa signification lorsque l'on découvre, et c'est l'objet de ce travail, que dans 80% des cas elle signale la présence d'une lésion organique.

Durant les deux dernières années, nous avons observé 35 cas de rétention de Télépaque dans une région quelconque du tube digestif, estomac, duodénum, intestin grêle. Parmi ces 35 cas, la preuve d'une lésion organique a été faite dans 28 cas.

Nous avons revu les dossiers de chacun de ces malades et chaque fois, nous avons tenté d'établir des corrélations entre les observations radiologiques, certaines composantes cliniques (l'âge, le sexe, l'activité du malade et la médication en cours) et les constatations anatomo-pathologiques.

Résultats obtenus

Parmi les malades examinés, 28 étaient des femmes et 7, des hommes; leur âge variait de 23 à 83 ans.

Lors de la préparation à la cholécystographie, deux patients étaient alités pour maladie chronique, 6 étaient alités pour crise aiguë, alors que les 27 autres étaient ambulants.

Au moment de l'examen, aucune classe particulière de médicament n'était commune à ces malades.

Le tableau I énumère les endroits de principale rétention de la substance opaque. Seuls, en effet, deux cas sur 35 ne présentaient aucune rétention gastrique.

Le tableau II énumère en vis-à-vis les endroits de principale rétention et la nature variée des lésions qui les accompagnent.

TABLEAU I

Endroits de principale rétention	*No. de cas*
Oesophage	2
Estomac et bulbe	28
Duodénum	4
Grêle	1

TABLEAU II

Endroits de principale rétention	*Lésion*	*No. de cas*
Estomac et bulbe duodénal	Cholécystite aiguë	2
	Calculs vésiculaires	4
	Calculs et ulcère pylorique	3
	Calculs et néoplasme gastrique	1
	Calculs et empyème vésiculaire	1
	Calculs et endométriose colique	1
	Ulcère petite courbure	1
	Ulcères pyloriques	3
	Ulcères duodénaux	4
	Iléus paralytique	1
	Hernie diaphragmatique	1
	Ascaris du grêle*	1
	Appendicite aiguë	1
	Syndromes fonctionnels	3
	Angine de poitrine	1
Duodénum	Epithélioma des voies biliaires et calculs	1
	Cholécystite aiguë calculeuse en voie de perforation	1
	Anomalie congénitale à l'angle de Treitz	1
Oesophage	Compression extrinsèque par aorte	1
	Hernie diaphragmatique**	1
Grêle	Adhérences et occlusion sur le grêle distal	1
	Epithélioma du jéjunum preximal	1

**diagnostic radiologique non confirmé.*
***n'a pas été contrôlée par repas Baryté.*

A ce tableau, nous ajoutons quelques clichés particulièrement démonstratifs de malades porteurs de lésions diverses avec rétentions à différents niveaux. Les cholécystographies ont été suivies d'un repas baryté chaque fois qu'il a été possible et utile de le faire.

L'aspect radiologique de la rétention est soit granulé (figures 1 et 2), soit sous forme de pâte homogène (figures 3 et 6).

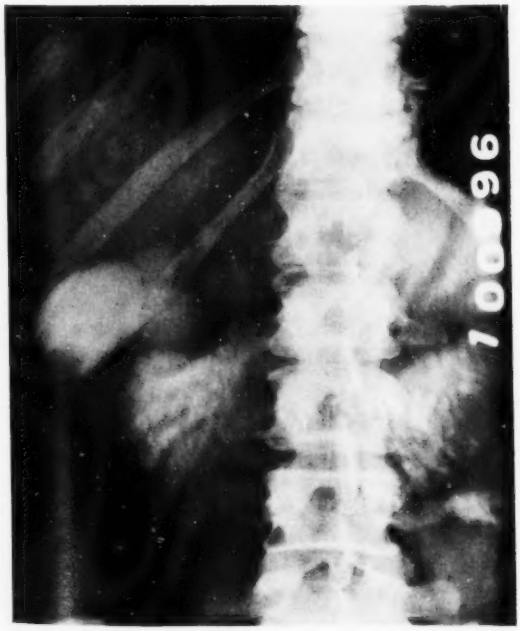
**Travail présenté à la Société Canadienne-Française d'Electro-radiologie Médicale en mai 1959.*

Figure 1 — Mme P.G., 54 ans.

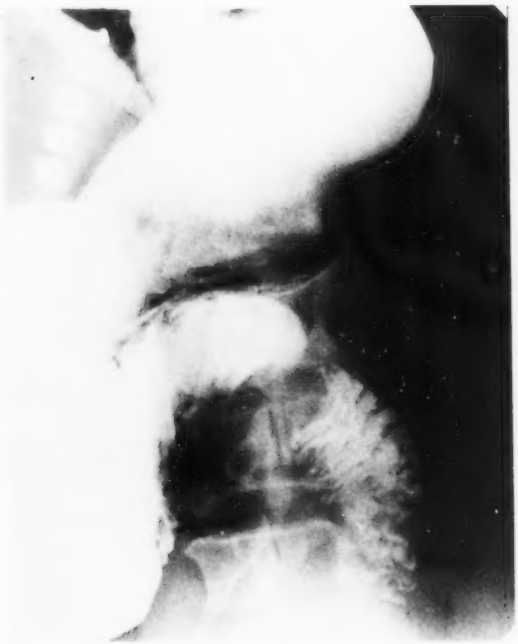
A gauche: Cholécystographie. Cet examen montre une vésicule assez bien opacifiée, mais de la rétention de Télépaque dans l'estomac dilaté.

A droite: Même malade. Repas baryté. Cet examen démontre que la cause de la dilatation gastrique est une sténose hypertrophique du pylore (confirmée à l'opération).

Figure 2 — Mme E.D., 58 ans.

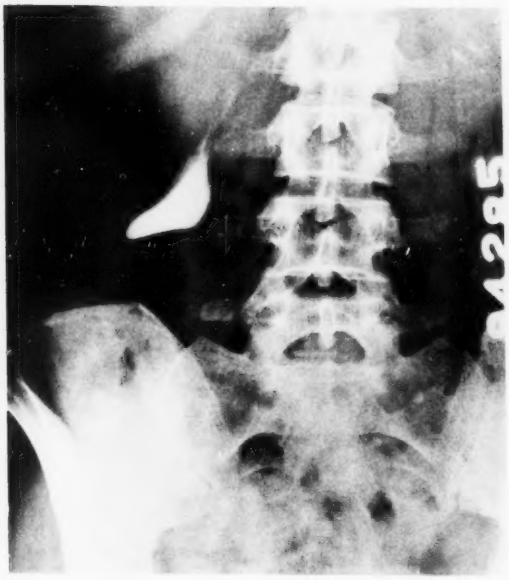


A gauche: Cholécystographie. La vésicule est normale. Il y a rétention de Télépaque dans l'estomac et le duodénum très dilaté.



A droite: Le repas baryté démontre une lésion sténosante (néoplasme malin) à l'angle de Treitz.

Figure 3 — Mme C.R., 41 ans.



Cholécystographie: la vésicule est normale. Les anses grêles distales contiennent une substance homogène, peu dense, représentant du Télépaque non totalement absorbé.

Cliniquement: crises de sub-occlusion.

Opération: libération d'adhérences au niveau du grêle distal.

Figure 5 — Mme N.C., 58 ans.

Cholécystographie. Lithiase, empyème vésiculaire et perforation dans le duodénum. L'empyème est reconnaissable par les images aériques discrètes.

Le calcul est passé dans le duodénum où il est encerclé partiellement de Télépaque.

Figure 4 — Mme R.D., 39 ans.

A gauche: Cholécystographie. La vésicule contient des calculs et il y a rétention de Télépaque dans l'estomac, surtout dans la grosse tubérosité.

A droite: Le repas baryté montre un néo envahissant tout le corps et l'antre gastriques.

Figure 6 — Mme A.R., 61 ans.

A gauche: Cholécystographie: vésicule normale. Rétention de Télépaque dans l'antre gastrique et grosse niche de la petite courbure visible par son contenu aérique.

A droite: Repas baryté: niche géante de la petite courbure, sans rétrécissement pylorique.

Figure 7 — Mme C.P., 75 ans.

Cholécystographie: Pachypleurite calcifiée et cholécystite aiguë. La vésicule n'est pas opacifiée après une double dose de Télépaque. La rétention siège à l'estomac et au bulbe.

Discussion

L'analyse de ces observations nous permet de relever les points suivants:

Premièrement, dans le cas d'obstruction, le Télépaque est retenu en amont de la lésion. La vésicule s'opacifie normalement si cet obstacle est incomplet ou est situé au delà du pylore. (figures 1, 2 et 3).

Deuxièmement, il arrive que la coexistence d'une lésion vésiculaire et d'une autre lésion sur le tube digestif soit clairement démontrée (figures 4 et 5) ou encore soupçonnée, sans que l'image que prend la rétention ait de caractère radiologique défini.

Troisièmement, l'endroit de la rétention n'est pas nécessairement l'endroit précis de la lésion. Ceci est démontré par les clichés présentés (figures 6 et 7) et s'est vérifié chez plusieurs autres malades atteints, par exemple, de hernie diaphragmatique où la rétention est située à l'antre gastrique, ou encore porteurs d'ascaris du grêle, atteints d'appendicite aiguë, etc., où la rétention est gastro-bulbaire.

La constatation d'une rétention d'opacifiant vésiculaire a suscité des commentaires dans la littérature médicale il y a déjà quelques années. Alors que plusieurs y ont vu une

cause de non-opacification de la vésicule (4, 6,7) peu se sont appliqués à rechercher la valeur diagnostique de ce signe.

Ainsi, en 1928, Skinner et al.[1] signalent certains rapports entre l'activité ulcéreuse, la rétention barytée gastrique et la non-opacification de la vésicule biliaire.

Plus tard, Sosman[2] décrit le pylorospasme, les fistules biliaires comme causes de non-opacification de la vésicule.

Seul, semble-t-il Gottlieb[3] en 1950, suggère que la présence de résidu de Télépaque dans l'estomac indique une lésion digestive haute qu'un repas baryté saura déceler avec une remarquable fréquence. Ainsi, sur 7 cas présentés, 5 étaient porteurs d'une pathologie gastro-duodénale dont la nature n'était pas nécessairement obstructive.

Teplick[5] par la suite ajoute 5 cas au dossier dans le même sens que Gottlieb.

Nos constatations s'accordent avec celles de ces auteurs, mais nous devons remarquer que les lésions gastro-duodénales ne sont pas seules en cause et que plusieurs états pathologiques et même fonctionnels entraînent la rétention de Télépaque.

Conclusion

La fréquence de cette observation est peu considérable en regard du nombre total de cholécystographies effectuées durant deux ans (environ 3,500 examens).

Notre expérience démontre cependant, que cette fréquence s'accroît à mesure que l'on s'exerce à rechercher ce signe particulier.

Nous sommes convaincus que s'il persiste de la substance opaque dans un endroit quelconque du tube digestif sur les clichés de cholécystographie, nous devons poursuivre l'exploration radiologique par un lavement et un repas barytés. Très fréquemment alors, ceux-ci démontreront la présence d'une lésion organique.

Il est évident que ce signe de rétention opaque pourrait être masqué et sa valeur moindre si le malade subit d'emblée les trois examens. Cependant, il arrive fréquemment qu'un médecin, devant un syndrome en apparence vésiculaire, ne prescrive qu'une cholécystographie. La rétention de Télépaque pose alors une indication de poursuivre plus loin l'examen radiologique du malade.

Résumé

Nous présentons 35 cas de rétention de Télépaque dans une portion quelconque du tube digestif. Dans 28 cas, soit 80%, cette rétention s'accompagne d'une lésion organique.

Des radiographies particulièrement démonstratives ont été choisies dans le but d'illustrer les aspects de la rétention accompagnant différentes lésions.

Les aspects radiologiques de cette rétention sont rarement spécifiques, mais cette seule rétention, pose à notre avis, l'indication de poursuivre l'exploration radiologique du malade.

Summary

Thirty-five cases of retention of Telepaque in the gastro-intestinal tract proximal to the colon have been presented.

Complete data as to the levels of retention and corresponding diseases are shown together with pertinent radiographs to illustrate interesting points.

In 28 cases (80%) the retention signalled an organic lesion in the gastro-intestinal or biliary tracts at or remote from the point of retention.

X-ray findings are seldom characteristic themselves, but the authors stress that such a retention should make a complete survey of the gastro-intestinal tract mandatory.

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THE DESIGN OF A WHOLE BODY IRRADIATION ROOM

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The research program of the Manitoba Cancer Foundation includes a study of the effects of whole body irradiation on the immunological response of animals. Thus far the irradiation has been carried out by means of a commercial teletherapy unit. With small animals this is feasible with such equipment, but it is hoped this work will be extended in the future to human patients, where the difficulties of obtaining uniform fields over the whole body are greater. We are particularly fortunate in Manitoba in that we are in the process of designing a new building to house the many activities of the Foundation. Consequently we can dig deep enough to house a whole body irradiation room in the subbasement. This paper is concerned with the factors which influenced our design of such a unit and finally presents the resulting design.

There have been several such units used or designed already for the treatment of humans with whole body irradiation. The simplest of these use a standard cobalt^{60} teletherapy machine with the treatment distance and port area adjusted to give a reasonably uniform field over most of the patient's length. Half of the treatment is given from one side, and then the position of the patient is changed so that the remainder of the treatment is given from the other side. An example of such a procedure is given in a paper by Miller, Fletcher and Gerstner[1].

A second unit was designed specifically for this purpose by Sahler[2] who used two commercial teletherapy units to irradiate the patient simultaneously from each side. Both these arrangements leave some doubt as to the homogeneity of the dose delivered to all parts of the patient.

Jacobs and Pape[3] have pointed out that this lack of uniformity of irradiation may be a contributing factor leading to rejection of marrow transplants in humans treated thus far. They point out that in small animals uniform radiation is easily achieved, and in small animals homologous bone marrow transplant has succeeded. This has led these authors, Jacobs and Pape, to construct a more elaborate irradiator consisting of eight (8) sources, one at each corner of a rectangular frame, approximately 6 ft. x 4 ft. x 6 ft. high. They hope, by means of beam-shaping filters, to provide an area of uniform dose-rate to a patient confined to a treatment area between the sources. Their exposure dose-rates are designed to be about 250 r maximum per hour, and they propose to study the effects of total body irradiation in doses up to 2,000-2,400 rads, probably fractionated.

One further point should be noted about all the irradiating facilities mentioned so far, and that is the relatively low dose-rates necessitating exposures of several hours. The patient's comfort and well-being are not well served by such a long treatment period when no mobility is possible.

Consequently, in the design of our unit, one of the requirements was that a patient should have considerable freedom of movement without leaving the area of uniform irradiation.

Briefly the design criteria for our irradiator were as follows:

1. A maximum dose-rate of 1 r/min ± 2½%.
2. A treatment volume 11 ft. square x 6 ft. high.
3. The treatment volume must be under constant scrutiny by a staff member at all times.
4. The dose-rate must be capable of variation.

The first suggestion was to use two opposing sources, as in the Sahler irradiator mentioned above. Such an arrangement gives a lower dose-rate at the center of the room than at the edges. The difference may be reduced by moving the sources further apart but this, of course, means that an increased source activity is required for the same dose-rate. In Figure 1 is shown the individual source size required to irradiate an area 3 meters (10 ft.) long as a function of the dose-rate variation from the edge to the center of this area to yield a dose-rate of 1 r/min. It will be noted that two sources, each of 3,200 curies, would be required for 5% variation in dose-rate from the edge to the center of a rectangular area 10 ft. long, and that the source separation for such an arrangement would be 77 ft. Because of the large size of

* *Presented at the Annual Meeting of the Canadian Association of Radiologists on January 24, 1961. Saint John, New Brunswick.*

these sources and the overall length of the room required to house them, further designs were considered.

Our second proposal made use of four sources, 3 ft. off the floor in a square array 26 ft., on a side giving rise to a central diamond-shaped area of uniform dose-rate (Figure 2). The size of the treatment volume was too small with this arrangement. To improve this, we would either have to separate the sources more or attempt to build up the central dose-rate.

Finally, we attempted to build up the central low spot by two small sources, one below the central floor area and the other above. This configuration is seen in Figure 3 where the elevation shows a large pit beneath the treatment volume. This must be covered by light construction in order not to attenuate the radiation from the bottom source. The resulting dose-rates, if each central source is 2½% of the corner source, are given in Figure 4.

This arrangement will require four sources of 310 effective curies of cobalt^{60} and two sources of 7.7 curies effective to provide an average dose-rate of 1 r/min.

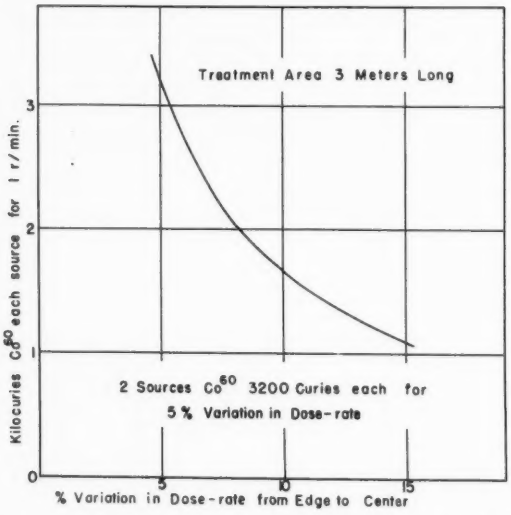

Figure 1 — The source-size required in a two-source arrangement is shown as a function of the maximum permissible variation in dose-rate from the edge to the center of the area of "uniform" irradiation. For 1 r/min ± 2½% in an area 10 ft. long, 2 sources, each 3,200 curies, are required 77 ft. apart.

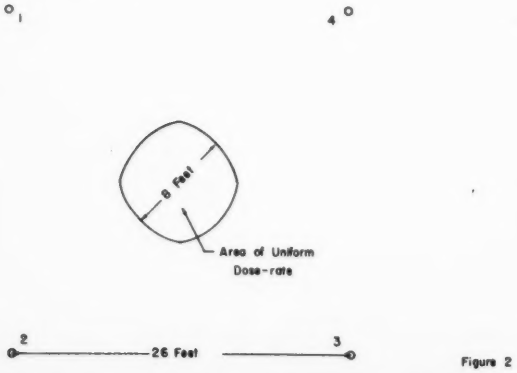

Figure 2

Figure 2 — The area of "uniform" irradiation is shown in relation to the source position for a four-source arrangement.

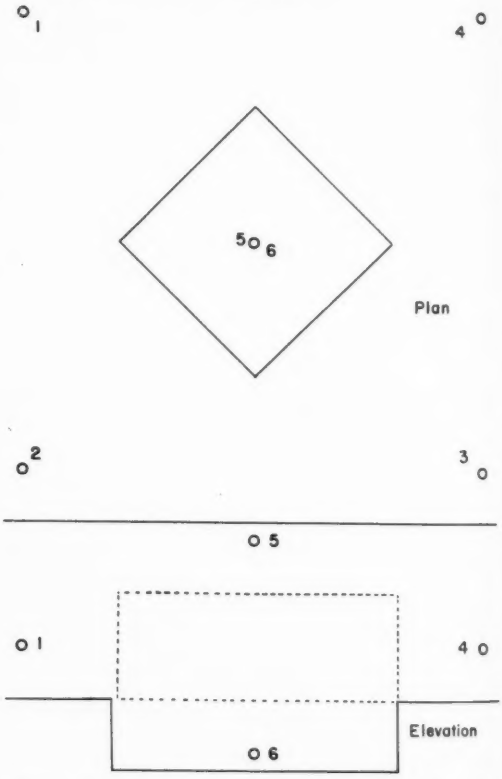

Figure 3 — The plan and elevation view of a six-source arrangement. Here source numbers 5 and 6 are each 2½% of the individual corner sources numbered 1 to 4.

The volume of uniform dose-rate is a square 11 ft. on a side and 6 ft. high, with the exception of a region near the floor, and a second one near the 6 ft. level in the center of the room. It is proposed to finish this volume off as a room by means of drapes or possibly light construction walls.

After the sources are assembled a considerable amount of preliminary work will be required to make certain that our uniform dose-rate is in fact realized. Part of this will

be necessary because of the difficulty of securing sources that are equal to about 1%. Any irregularities in the source activities can, however, be easily corrected by using filters to attenuate the stronger beams of radiation until equal dose-rates are achieved. Additional filters can then be used to vary the overall dose-rate. In this case equal filters would be placed in front of each source.

A further and possibly more serious source of irregularity in the dose-rate will arise from γ-rays scattered off the floor and walls.

Preliminary measurements indicate that the level of scattered radiation from the floor alone could vary from perhaps 15% of the primary radiation at floor level to about 4% of the primary beam dose-rate at 6 ft. above the floor. There are also equally serious variations in the horizontal direction, the amount of scatter relative to the primary increasing with distance away from the source. Such large variations are certainly serious when one is attempting to maintain the overall variation to within ± 2½%.

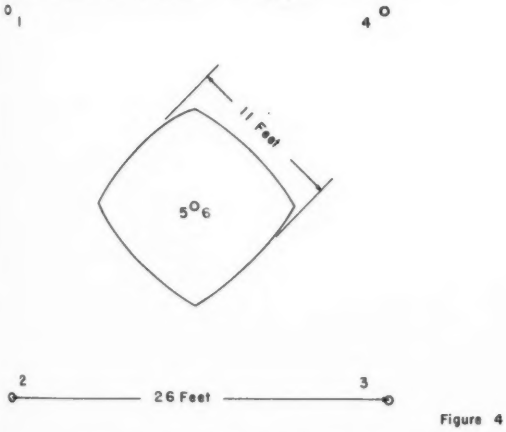

Figure 4

Figure 4 — The area of "uniform" irradiation is shown in relation to source position for a six-source arrangement.

We have attempted to reduce this variation somewhat by making the floor under the patient area as light as possible with the concrete slab sunk an additional 4 ft. below the floor level. We propose to eliminate the remainder of this variation by means of specially shaped filters. This seems possible since the scattered dose-rate varies smoothly from floor to ceiling. Also, the central area where our dose-rate is lowest receives the greatest amount of scatter.

The measurements of scattered dose are shown in Figures 5 and 6. These were obtained by irradiating a large area of floor with a commercial cobalt^{60} machine. The field sizes obtainable on such a machine are, of course, much too small to irradiate the floor area required, so that we were forced to irradiate the floor in a patchwork fashion, one area at a time, maintaining the source in nearly the same place but turning the source-head. The scattered dose for each irradiated area was measured and the results added to give total scattered dose. The source was 3 ft. off the floor and the irradiated area was 13.1 m.^{2}, the nearest edge of which was 1 meter from a point on the floor directly below the source. The lower part of Figure 5 shows an elevation of the physical arrangement used. The small circles marked I, II, iII, etc. represent points of measurement. The total dose measured at these points had to be corrected for radiation from the source transmitted through the source-head in order to yield the scattered dose. These scattered doses were then expressed as a % of the primary radiation that

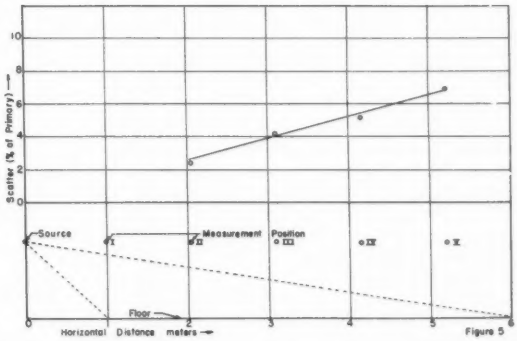

Figure 5 — The scattered dose-rate, expressed as a function of the primary dose-rate at the point of measurement, is shown for various positions from the source. Each measurement point is 3 ft. above the axis of the floor area irradiated. The geometry of the irradiation is shown to scale in the lower part of the figure.

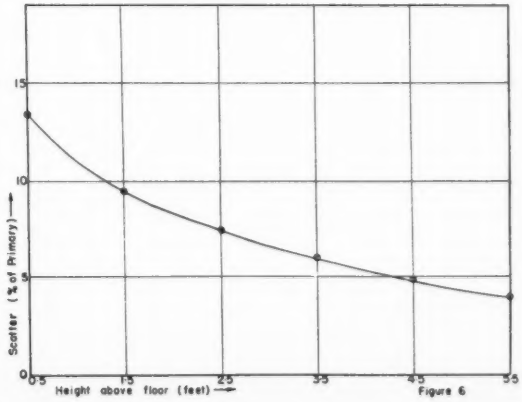

Figure 6 — The scattered dose-rate at several heights above the floor is shown at a distance of 17½ ft. from the source.

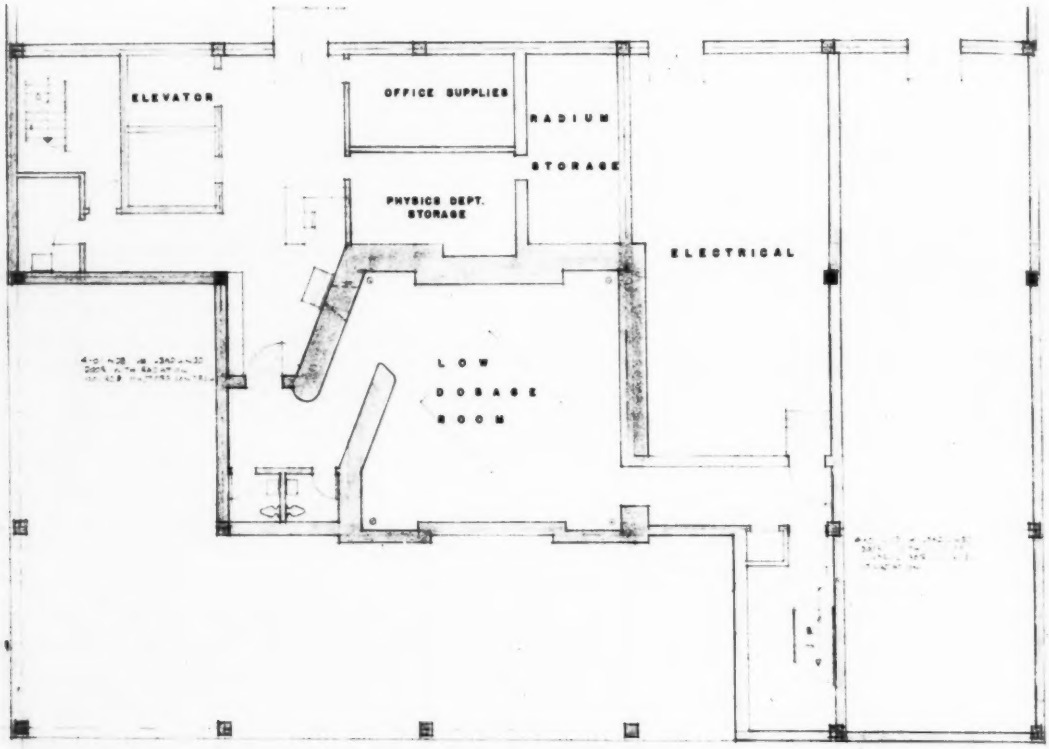

Figure 7 — Floor plan of proposed whole body irradiation unit.

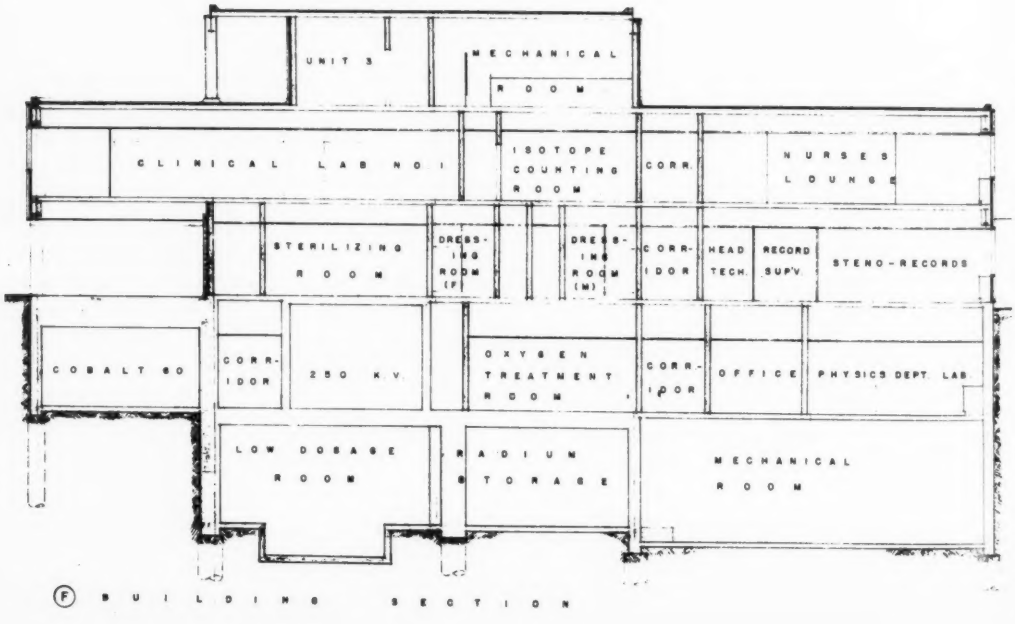

Figure 8 — Vertical section of proposed building showing location of whole body irradiation unit in the sub-basement.

would have reached these points if the main beam had been directed toward them. The upper part of the figure shows the variation in scattered dose at the 3 ft. level with distance from the source.

The vertical distribution at position V was obtained in the same manner and is shown in Figure 6. Further measurements of this scattered radiation will be reported elsewhere.

We are proposing to place the operator just outside the irradiated volume, shielded by a three-foot thick concrete wall. The floor plan is shown in Figure 7. Door interlocks will be provided at both entrances to the room which will replace the sources in the "off" position if the door should be opened inadvertently during the treatment.

The operator will be able to view the patients at all times by means of either a direct vision water window containing sufficient zinc bromide to increase the density of the water to that of concrete, or a closed-circuit television set. Work is in progress to determine the relative advantages of each method, but at the moment it would appear that the television circuit will be the more satisfactory.

Figure 8, a vertical cross-section of the proposed building, shows the treatment area in the sub-basement.

In summary, this paper has given the design criteria for a whole body irradiation unit and the proposed method of achieving these aims.

Summary

On the basis of other systems for whole body irradiation, some of which are discussed, design criteria are laid down from which a plan of a whole body irradiation unit is evolved. This plan is given in some detail and methods of overcoming some irregularities in the dose-rate due to source activity variation and scatter are suggested.

Résumé

Se basant sur les systèmes existants pour irradiation totale du corps, les auteurs, après analyse de quelques-uns de ces systèmes, établissent des critères de mise en plan pour le montage d'un appareil à irradiation totale. Ayant exposé les plans d'un tel appareil, ils suggèrent des moyens de corriger les irrégularités dosimétriques dues au débit de la source et à la diffusion des rayons.

ACKNOWLEDGMENTS: The authors wish to acknowledge the advice and assistance of Dr. P. A. Macdonald, who did much of the preliminary design, and Mr. E. M. Campbell, who has checked our calculations and assisted in the final design of the whole body irradiation unit.

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SYMPOSIUM ON RADIATION EXPOSURE

The Research Branch, Division of Radiological Health, United States Public Health Service, is sponsoring a symposium entitled, "Technological Needs for Reduction of Patient Exposure from Diagnostic Radiology." The purpose of this meeting is to evaluate the status of laboratory research as it applies to this subject. Approximately fifteen papers will be given which will summarize the state of the art and point out future areas for investigation. The four main categories which will be covered are human and phantom dosimeters, radiographic equipment, fluoroscopic and intensifier equipment, and radiographic grids, screens and films. Drs. H. Wyckoff, C. Braestrup, R. H. Morgan and E. W. Webster will act as moderators for these sessions.

The dates of this meeting are March 5 and 6, 1962. The place is the main auditorium of the Health, Education and Welfare Building, Washington, D. C. For information and tickets contact:

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RADIUM APPLICATORS IN THE TREATMENT OF CARCINOMA OF THE CERVIX

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Radium has been used in the treatment of carcinoma of the cervix since 1905. The first period, from that date to 1910, marks the time when poorly-screened radium was used, chiefly as a palliative measure, in advanced and inoperable cases; in 1909 Dominici showed the beneficial effect of screenage and its influence on the safety and efficacy of radiation. The earliest series of cases treated by radium was published in 1909 by Cheron and Duval; by 1914 these authors had treated 158 cases of inoperable carcinoma of the cervix, and in 77 they obtained complete regression of the growth. Their method consisted of cavitary radiation, using large quantities of well-filtered radium.

The development of interstitial methods in other anatomical situations led for a time to an experimental trial of needling of carcinoma of the cervix, but the results obtained in this site were not encouraging. Waterman is an exponent of this method and his results are as satisfactory (80% in cases thus treated) as those with other types of treatment, but there is a certain amount of danger in the use of this method and it is not recommended by most therapists.

The objectives to be obtained in modern treatment with radium are: 1. the radiation of the whole length of the uterine canal; 2. the radiation of the disease in the vagina; 3. the application of these sources so as to produce a satisfactory dosage at the lateral pelvic walls, and 4. care in protecting, as much as possible, the bladder and the rectum. The types of radium techniques based on these principles most in usage are the Stockholm method, developed by Heyman, and the Paris method, developed by Regaud and Lacassagne. The main differences between these two methods are (a) in the quantities of radium used, (b) the duration and spacing of the treatment, and (c) the form and method of applying the vaginal radium source.

In 1927, Sir George Newman, Chief Medical Officer of Health of Great Britain, stated, regarding the results of radiological treatment in uterine cancer, "We find that, broadly speaking, the results obtained are the equal of those obtained by operation, namely, survival for five years of about 40% of patients suitable for operation. In addition, survival to a similar period of about 12% of patients who are inoperable is secured." He also stated, "When it is remembered that effects of this order can be secured without many of the risks, disadvantages and inconveniences attendant upon operative treatment, one is impelled to inquire whether these remedial agents, radium and X-rays, are used as widely as they should be in England."

In 1928, at the International Conference on Cancer held in London, W. P. Healy of New York stated that radiation offers better results than surgery. At that meeting Heyman reported that in 145 operable cases treated by radiation alone, a 46.2% five-year survival rate was obtained. Now we know that this is a reasonable rate of survival for all cases treated in all stages.

In recent years there has been a definite improvement in the five-year survival rate which has increased for all stages seen. The reason for this was discussed by Kottmeier in the Annual Report on Treatment of Cancer of the Cervix.

On data from 86 institutions treating cancer of the cervix, in twenty-two countries throughout the world there has been an overall increase in recovery rate over the past twelve years from 27.6% up to 44.8% five-year survivals. Part of this more favourable result is due to earlier treatment, and part to improved therapy. Over the past five years there has been an increase of Stage 1 cases from 19.1% to 23.6%. Dr. Kottmeier has shown that there is an increased survival rate due to improved therapy.

Along with a greater survival rate there has been a decrease in morbidity associated with radiation therapy. In our own clinic we have found significant trauma, amounting to only 4.7% of the cases treated. By surgery, the percentage was 15.

Kottmeier concludes that the level above which there is an increase in rectal injuries is 5,000 gamma roentgens, and that a dose of 2,400 roentgens to the rectum in 24 hours is the maximum that should be used.

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Blomfield is quoted in the Proceedings of the Royal Society of Medicine, 1947, as follows: "Using three treatments over two or three weeks, the safe tolerance doses would appear to be in accordance with the following table:

Structure	*Tolerance locally in roentgens*
Rectum	4,000
Base of bladder	5,000
Bowel in contact with posterior uterine wall of fundus	5,000
Vaginal vault	12,000 to 15,000 "

We are indebted to Drs. Gray, Gusberg and Guttman of New York (American Journal of Obstetrics and Gynaecology, Vol. 76, Pages 629-633, September, 1958) for a study on pelvic lymph node dissection following radiotherapy. Surgical node dissection was carried out three months after completion of radiotherapy if the primary lesion was healed. The patients usually received 6,000 mgm. hours of radium in 100 hours, producing 8,000 to 10,000 gamma roentgens to point A. The external radiotherapy varied, but in general consisted of 3,500 roentgens tumour dose given by a 250 KV machine or 5,000 roentgens given by a supervoltage unit.

Of the 51 patients with Stage 1 or 11 lesions in whom pelvic node dissection was done, only one had positive nodes after full radiotherapy, an incidence of 2%. In patients in whom radical hysterectomy was done as a primary method of treatment, the incidence of positive nodes was 18.5%. While this surgical procedure has proven helpful in assessing the effect of radiation on nodes, it has not been a satisfactory procedure from the patients' standpoint, as the morbidity is high. Of 55 patients operated upon, 25 developed leg edema, 7 thrombophlebitis and 9 wound complications following such surgery. The authors conclude, "Pelvic lymph node dissection after full radiation for treatment of cancer of the cervix is not therapeutically sound because of prohibitive morbidity."

Radium Therapy

In almost all centres treatment consists of placement of radium in the uterus and against the cervix. The procedure is modified in many ways reegarding amount of radium, types of containers, timing and loading.

The three basic methods are:

1. *The Stockholm Method:* The important feature of the Stockholm method is the high degree of individualization of treatment attainable. One of these modifications is the use of intra-uterine radium alone if infection is present. Another is the use of large quantities of radium for a short time. Usually two or three applications are used, fractionating the dosage.

2. *The Paris Method:* The Paris method developed a technique of intracavitary radiation based on the principle of continuous radiation prolonged over 120 hours. One treatment only is given as opposed to two or three fractional treatments of the Radium-hemmet. Half the radium (66.66 mgm.) is inserted into the uterine cavity and half into the vagina. The vaginal application is held in three corks; two of these are joined together by a spring known as the colpostat, and the third can be used between the outer two if necessary. The containers are removed daily and replaced after vaginal douche.

3. *The Manchester Technique:* This is a modification of the Paris method. Treatment is divided into two fractions and X-ray therapy is employed between the two radium treatments. Point A is used in connection with this therapy, a point in the paracervical triangle, 2 cm. up from the lateral fornix and 2 cm. out from the centre of the uterus. Special mention may be made of the rubber ovoids used instead of the Paris corks. The shape of the ovoid follows the isodose curve of the radium source contained within it. Three sizes of ovoids (small, medium and large) are used with a washer or spacer between them. Very thin tubes are used for the intrauterine radium to avoid excess dilatation of the cervix.

At the Christie Hospital and Holt Radium Institute, Manchester, Dr. R. Paterson reported a five-year survival rate of 39%. In general, cases of cervical carcinoma were treated by the Manchester method. Stage I and II cases were treated by intracavitary radium to a dose of 8,000 roentgens at point A, the treatment being given in two insertions at a week's interval. Stage III cases were treated with intracavitary radium to a dose of 6,500 roentgens at point A divided into two insertions at a week's interval. In addition, these cases received parametrial X-ray therapy to a dose of 3,000 roentgens at point B in twenty days. The X-ray therapy was given either before, after or between the radium treatments.

Dr. Tod of Manchester considered the loading of the radium and discussed in a paper in 1953 the relationship of the intrauterine to the intravaginal dose, and concluded that at point A a contribution of 1.8 from the uterus as compared with 1 from the vagina was a satisfactory distribution. This contrasted with the earlier Manchester 1:1 relationship.

Dr. S. T. Cantril of Seattle, with one of the highest five-year survival rates in the world, uses an equal amount of radium inside the uterus and in the vagina and delivers 4,000 mgm. hours to each in a single dose; the intravaginal treatment is given about ten days after the intrauterine. We have found on physical assessment that this arrangement delivers the dose at point A in a ratio of 2.25 from the uterus to 1 from the vagina.

One might think that a comparison of the five-year survivals in Stage I would be indicative of the advantages of either method. In Manchester this rate is 67% and in Seattle 80%. On the basis of this, we might conclude that the Seattle method is better, but more information on the material would be required to decide. Seattle reports 40% of its cases in Stage I, Manchester only 5%. In Stage II there is greater similarity in the results; Manchester reports 51% five-year survivals and Seattle 56%. One is impressed with the equal-loading, single-dose technique used by Dr. S. T. Cantril which he refers to as "Modified Manchester".

A survey of two Canadian clinics shows a variation in the method of treatment.

In the Kingston Clinic, for twenty years, treatment consisted of an intrauterine dose of two 20-milligram tubes in tandem with an intravaginal dose of 20 milligrams in each fornix, plus one or two 10-milligram tubes added between them, depending upon the width of the upper vagina. Over a period of three weeks three applications were used. This resulted in an intrauterine dose of 3,000 to 3,750 mgm. hours and an intravaginal dose of 3,750 to 4,500 mgm. hours. The estimated total radium dose at point A for the three applications was 7,500 roentgens. This was followed by external irradiation which increased the dosage at A to approximately 9,500 total roentgens.

In the London, Ontario Clinic, the Paris technique was followed using an intrauterine dose of 3,200 to 4,000 mgm. hours, and an intravaginal dose of 3,600 to 4,440 mgm. hours. Timing however was considerably different in the two clinics. The London technique required a total of only twelve days compared with three weeks in our Kingston Clinic. Results, however, were similar, the five-year cures in Kingston being 46% and in London 47%.

Many types of applicators have been developed by various clinic centres throughout the world. Some well-known applicators are the Ernst applicator, the Manchester ovoids, Swedish silver boxes, the colpostat of the Paris technique and the Blomfield apparatus as described in the British Journal of Radiotherapy published in 1955.

Because of the better physical shape of the Manchester ovoids, about three years ago we decided to change to this applicator. After the placing of the ovoids and packing them in position in the fornices, X-ray examinations were made. They demonstrated that it was very difficult to maintain the cervical radium in proper position in relation to the tumour. Another difficulty was easy displacement of the white cork in the rubber ovoids. Therefore, we set out to try a new approach to the problem.

After careful consideration of various thermoplastics it was decided that the one best suited for this applicator was acrylate and methacrylate resin, commonly called perspex, plexiglas or lucite. This resin meets all of the requirements for an applicator of this type. It is non-toxic, non-absorbent, low filtration and workable.

During the course of construction the only difficulty encountered was the drilling of the intrauterine tube. It was found that, after the hole had been drilled, small cracks and checks would appear on the inside surface of the hole. This was believed to be caused by internal stress set up in the perspex rod when it was extruded. It was found that after the perspex rod was annealed at approximately 34°C for 12 to 20 hours prior to use this annoying fault was eliminated.

After considerable use it was noted that some amber discolouration appeared. This was thought to be caused by radiation, but it does not seem to be detrimental. The heat distortion level of this perspex is 50° to 85°C; the softening point is 66° to 123°C. Its tensile strength is 4,000 to 10,000 lbs. per sq. in.; it is not effected by immersion in cold water; it is practially non-absorbent; it is resistant to most acids and oxidizes with strong acid solutions only; it is resistant to alkalies; it swells or dissolves in alcohol, ketones and esters; chloroform may be used to soften two surfaces so that they will adhere, and the resin is resistant to all oils. It cannot be boiled, therefore cold Aqueous Zephiran, strength 1:750, acts as an excellent sterilizing agent.

Perspex, plexiglas or lucite is readily machinable in any manner. It may be threaded and turned. Metal polish (such as commercial Brasso) may be used to impart a highly polished surface so that the applicator is completely translucent.

From this material ovoids were made with screw plugs and handles at right angles, making it possible to hold the applicators during insertion. This was not satisfactory, so the handle was attached parallel to the long axis of the ovoid. This allowed the radium to lie at right angles to the intrauterine tubes. A washer could be used with two of these ovoids, and to facilitate this the washer was permanently attached to one ovoid. It was found that two ovoids could be joined solidly and inserted readily in the vertical plane. Following this, we developed a universal joint type of applicator with a deep recess between the two ovoids and a rounded end on the intrauterine tube with a

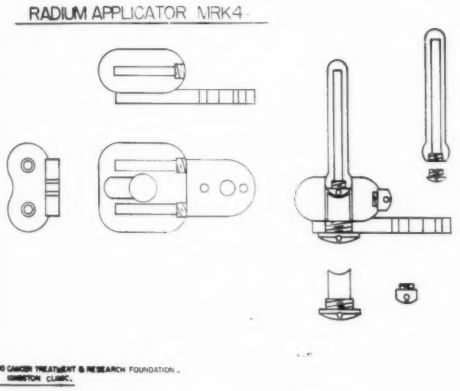
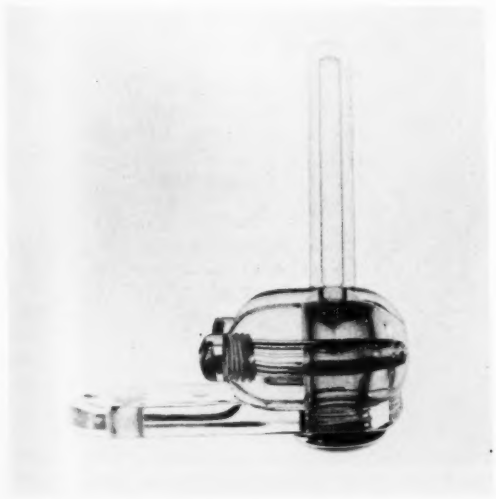
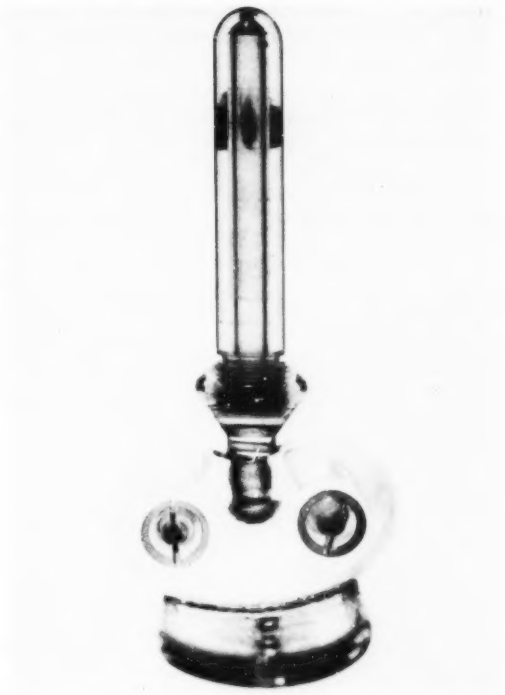


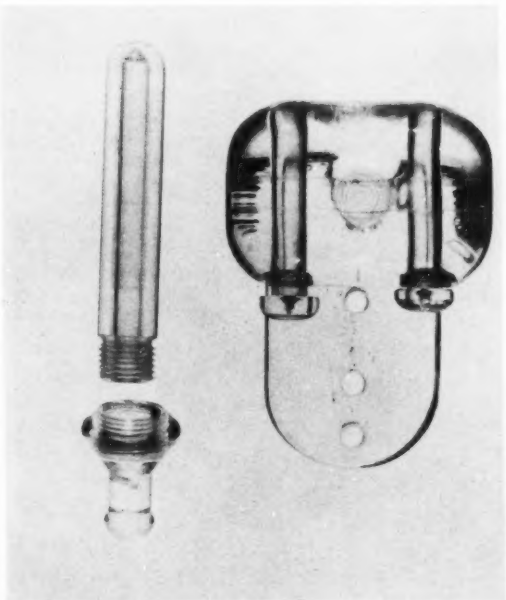
Figure 1 — Plan of applicator.

flared lower portion so that the two could interlock after they were inserted. In this way, it was possible to be certain of the position of the radium against the cervix





(Figures 1, 2, 3 and 4). An applicator was developed, with the intrauterine and intravaginal portions integrated, so that the intrauterine portion will flex forward 90° and also



Figures 2, 3 and 4 — The Perspex Applicator.

have some lateral deviation. This can be used only in the patient with a roomy vagina and a large introitus (Figures 5 and 6).

The use of sponge forceps, with two small attached metal lugs which fit into holes in the applicator handle, makes a very steady and firm method of holding the radium in place during packing.

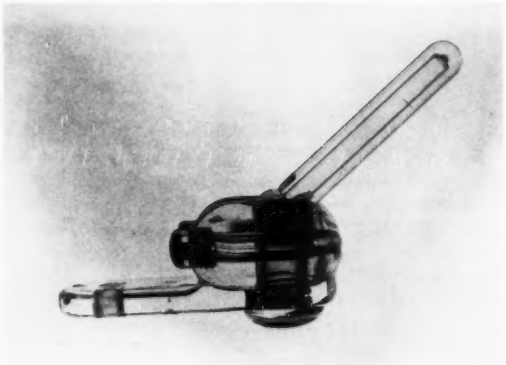


Figure 5 — Intrauterine tube tilted forward.

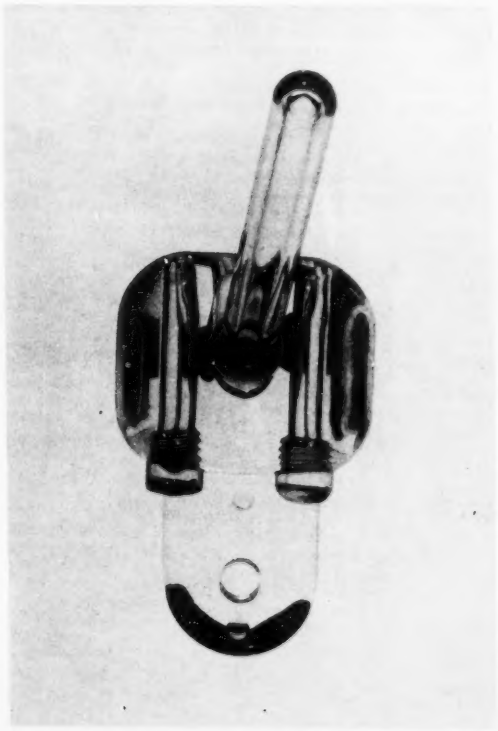


Figure 6 — View of applicator from above.

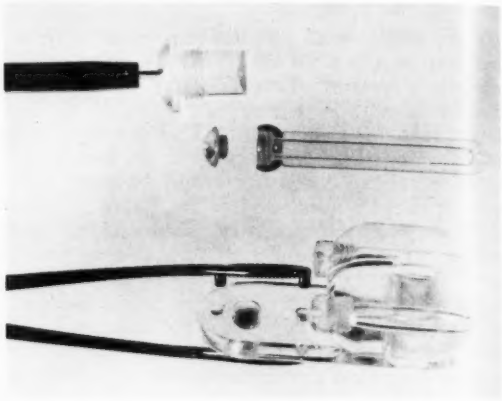


Figure 7 — Clamp arrangement for the intrauterine applicator and a screw driver in the groove in the head of the applicator.

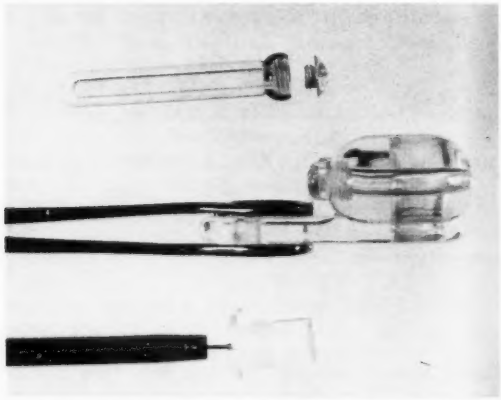


Figure 8 — Clamp closed holding the applicator.

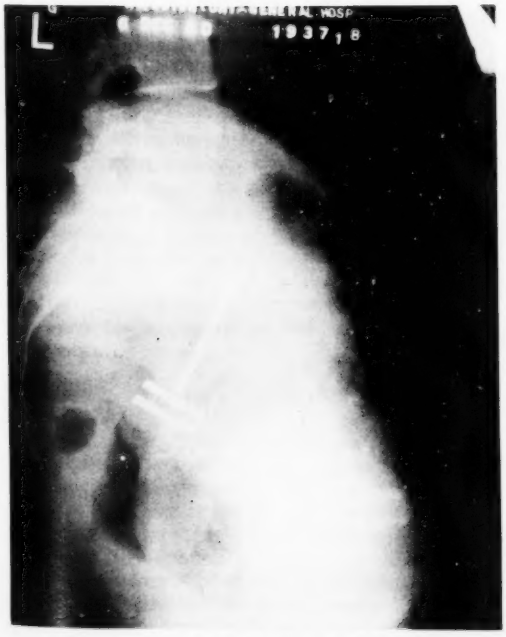
A special screw driver was also developed which will fit into a rounded slot and which will hold the cap after it has been released (Figures 7 and 8).

The usual loading is two 20-milligram tubes in tandem in the intrauterine applicator and one 20-milligram tube in each of the fornices. The loading produces a dosage ratio at Point A of 2.3:1. This applicator simplifies dosage estimation.

Physical calculations were carried out on the Manchester type of loading with 15 milligrams at the top of the uterus, 10 milligrams near the cervix and two vaginal ovoids containing 20 milligrams of radium in each. The dose rate at Point A due to the ovoids was calculated to be 19.5 r per hour, and from the intrauterine tubes, 32.5 r per hour. The total dose rate at A was 52.5 r per hour and the ratio of contribution, intrauterine to ovoids, was 1.7:1. Our Kingston applicators use tubes

with an active length of 2.4 cm. They contain 20 milligrams each. Two of these were placed in tandem in the uterus and one in each of two ovoids (Figures 9 and 10). The dosage at Point A from the ovoids was calculated to be 21.5 r per hour and from the intrauterine 48.5 r per hour, giving a total dose of 70 r per hour. The ratio of contributions, uterine to ovoids, was 2.3:1. The dose rates were calculated by using tables of Sievert integrals for filtered line sources of radium (Wilson, "Radium Therapy" Appendix III), the linear absorption coefficient of the platinum filter being taken as two reciprocal centimeters.

Isodose curves were constructed for a dose rate equal to that at Point A for the Manchester and Kingston arrangements, using two mutually perpendicular planes (Figure 11).



Figures 9 and 10 — Radium in the uterus.

It will be noted that the Kingston loading appears to carry the dosage a little further forward toward the bladder and backward toward the rectum. This dosage, however, is similar to that used in Seattle and Windsor, two places where the five-year survival rate has been high. The Paris technique also makes use of this equal loading arrangement.

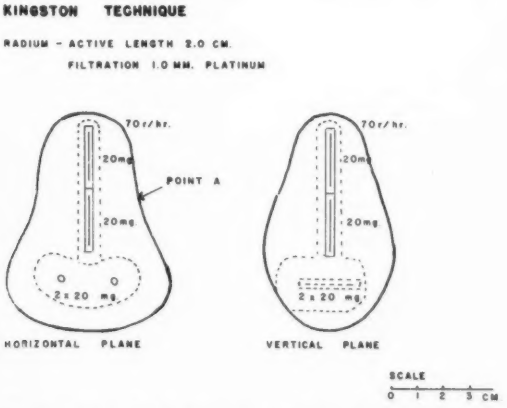


Figure 11 — Isodose curve of the dosage at Point A carried completely around the applicator in the horizontal and vertical planes.

Conclusions

1. Loading of radium applicators for carcinoma of the cervix has been considered.

2. The relationship of the intrauterine to the intravaginal radium dosage varies in different methods used. The Manchester method, with a 1.7:1 ratio, has been compared with the equal loading of radium in the uterus and against the cervix, producing a 2.3:1 ratio.

3. A resin, known variously as perspex, lucite and plexiglass, has proven very effective as a material from which to make the Manchester ovoids, and these have been joined in various ways to make it possible to link the intrauterine and intravaginal applicators. In this way, undesirable variations in the position of the radium are reduced.

4. Increased protection for the operator has resulted from the use of a long-handled forcep to hold the applicator, and by the development of a special long screw driver to attach the caps to the ovoids and the intrauterine tube.

Résumé

1. Les auteurs ont analysé les charges des applicateurs de radium utilisés dans les cancers du col utérin.

2. Suivant les diverses techniques employées, on note une variation du rapport entre la dose intra-utérine et la dose intra-vaginale. Deux techniques sont étudiées en détail, celle de Manchester qui donne un rapport de 1.7 à 1, et une technique à charge égale de radium intra-utérin et intra-vaginal produisant un rapport de 2.3 à 1.

3. Une résine connue sous le nom de perspex, lucite ou plexiglass s'est avérée très efficace comme matériau servant à fabriquer les ovoïdes de Manchester; ceux-ci ont été assemblés de diverses façons pour rendre possible l'union des applicateurs intra-utérins et intra-vaginaux. On a pu ainsi réduire des variations indésirables de positions des foyers telles que mises en évidence par les radiographies.

4. Pour assurer à l'opérateur une plus grande protection, on utilise une pince à long manche pour tenir l'applicateur et on a mis au point un long tournevis spécial permettant de fixer les calottes aux ovoïdes et le tube intra-utérin.

REPRODUCTIONS IN THE JOURNAL

With this issue, the Journal of the Canadian Association of Radiologists changes its method of reproducing illustrations. After considerable study, the Editorial Board has decided to use the lithographic method for reproduction of cuts, rather than the method of photo engraving.

We think our readers will be interested, and we hope they will approve of the change. Reproduction of X-rays is about the most difficult problem which can confront the printer and publisher. The editors of the Journal are fully conscious of the difficulties encountered by the engraver and the printer in reproducing the extremely fine shades of contrast inherent in radiographs. They are familiar, too, with the anguish of the author whose contribution is vitiated by loss of detail and contrast in his radiographs. While it must be recognized that there is no method of duplicating on the printed page the complete range of density and detail visible on the original radiograph viewed by transmitted light, we believe that the method being introduced herewith may bring us a little closer to the unobtainable ideal.

POSITION WANTED

DIAGNOSTIC RADIOLOGIST, certified by the Royal College of Physicians and Surgeons of Canada and the American Board of Radiology, desires suitable position. Reply to Stanley Tchang, M.D., 4267 Isabella Street, Montreal, P.Q.

TWO SPECIALTIES IN ONE

The attention of the readers of this Journal is drawn with enthusiasm to the article "La radiologie et ses problèmes de croissance" which appeared in the April 4, 1961 issue of "L'Information Médicale". This article has been favourably received and has also provoked discussion and controversy among our colleagues. Reprints (in French) may be obtained by writing to Dr. G. Pinsonneault, Hôpital Hôtel Dieu, Montreal, Canada.

FOR SALE

Modern radiological office with Picker therapy and diagnostic equipment. Entire office air conditioned. Suite 319, Cleaveland Building, Rock Island, Illinois.

ERRATUM

The Regina General Hospital, Regina, Saskatchewan, has just advised us of an error made in the copy which was sent to us for publication — page 99, Volume XII, No. 3, September 1961. The number of beds should read 807 instead of 94.

A METHOD AND PHILOSOPHY FOR INTERPRETATION OF RADIOGRAPHS

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"We are no other than a moving row
Of magic shadow-shapes that come and go."
Omar Khayyam.

The expression "seeing is believing" suggests that simple observation alone brings truth to a situation. In radiographic film interpretation, what is found is often that which is specifically looked for; the truth may be obscure. To look is not to see, and to see is not to understand. To paraphrase a familiar expression, one might say that there is more to vision than meets the eye.

Medical radiography and conventional photography have much in common. Both use radiation-sensitive materials to record the appearance of a subject at a particular moment in time. Both are documentary and informative but with different motives. Interpretation of photographs is learned at such an early age that we tend to forget that it is a developed faculty. Although highly efficient it is subject to real deficiencies which may be uncovered experimentally, particularly when the camera has assumed a position seldom taken by the eye. Reading of radiographs is an art which calls for an unfamiliar approach to pictures. One must get along without the modelling effect of shadows so helpful in our visual world. The radiographic image, if it can be called a shadow at all, is a shadow-graph with penetration, a portrayal of the subject, magically rendered transparent, in which anything that is recorded has added to it some effect of everything in front of and behind it. The masking over-lay of one object by another, which is the key to position in our everyday visual experience, is lost in radiography by the very nature of the process.

In learning to read radiographs one should first mentally reconstruct the perspective of the examination, substituting the eye for the focal spot. The medical interpretation which follows is in three parts: first, a recognition of the structures based on a knowledge of the anatomy of the area; second, determination of a departure from the normal appearance of these structures; third, a consideration of the pathological processes which may account for this appearance. Observation must precede deduction. To make an error in the first stage of recognition is the equivalent of the loss of the horse-shoe nail which led to the loss of a kingdom.

Those who have not progressed so far in radiology that their reading habits have become deeply entrenched should give some thought to developing a methodical plan to be followed in interpretation. A consciously ordered method of analysis will in time become a good habit followed without an awareness of its presence. In the belief that training in this respect is worthwhile, a simple plan is offered for consideration, with some comments upon the form of the interpretation.

The first step in reporting is to establish the identity of the films. In the absence of previous films of the patient one may look for discrepancies with respect to age, size and sex. One should next determine if all the films taken in the examination are present; it is very upsetting to be confronted at some later date with additional findings from a film presumed to have been reported. At the same time one may note if the examination has fulfilled the request from the referring doctor. Adequacy or inadequacy of the examination may be apparent at this stage but may not be decided until interpretation has been completed.

The next stage is a reconnaissance of the radiograph in the form of a coarse scanning. The top left-hand corner is the logical place to begin for it has been long established as the starting point for our conventional reading habits. It is suggested that one should use horizontal eye movements, back and forth, while progressing downwards to reach the bottom right-hand corner. Having given the film an over-all rough inspection, one should next proceed to a more detailed scrutiny of individual parts, identifying and appraising them with estimations of deviations from normal. This detailed inspection should follow a new pattern. The complexity of this pattern may be varied greatly to suit one's individual tastes. It is made by drawing up a list of questions to be mentally answered for

each major examination area. For example, with films of the skull, one must specifically consider the pineal, the sella turcica, the nasal sinuses, the mastoid cells and the internal auditory canals. The list that one might record may seemingly be endless, but in practise there are areas which are such potent sources of significant information that they should be sought out and not left to force themselves upon one's attention. Since the sequence and length of the list will determine the pattern of eye movements and conscious thought, it should be drawn up with economy of time and effort in mind, but without jeopardizing thoroughness.

In following any pattern decided upon, one initially looks for deviations from the normal with respect to form, position, dimension, texture, number and density, and other qualifications which do not specify types of pathology. After an abnormality is recognized one should next consider the mechanics of its production, thinking in terms of the cross-sectional anatomy of the region and the radiographic principles involved in the production of "shadows". Only then should one go on to think in terms of the pathological processes which could best explain the findings.

The above method, however simple it may be, takes longer to describe than it takes to use in practise. The need for haste is not always present, but whatever the speed, the pathway should be a familiar one. The importance of repetition in determining ease of recognition is already shown in our reliance upon standardized projections for examination.

Failure to follow some logical sequence of thinking while seeing will surely lead to embarrassing errors of omission which are much more difficult to account for than errors in interpretation of the nature of an obvious lesion. The novice may take some comfort from the knowledge that even the most experienced radiologist makes inexplicable errors of omission, and in two readings may disagree with himself in a high percentage of cases. Garland[1], in a careful study of the interpretation of miniature and full-sized chest films by a group of radiologists, has shown how astonishingly extensive the errors may be, and comments to the effect that judgment in other clinical fields may be just as faulty. However, until clinicians become aware of their own deficiencies through some parallel method of investigation, the radiologist caught in error must suffer in silence, consoled only by his understanding colleagues.

Brevity in reporting is always welcomed by the secretarial staff and finds favour among clinicians. The latter have been remarkably tolerant of long-winded reports in which the essence may be that nothing out of the ordinary has been found, and also of reports in which a truly significant finding is buried in a frothy discourse. Reports, particularly if long, should have the main findings recorded in a summary.

Sometimes, however, a report labelled simply and correctly as "normal" may not suffice. In some areas of examination, normal structures which are variable in demonstration may call for comment. For example, the presence of a pineal in a normal position should be recorded, for it is additional evidence of normality. A bald "negative" report may be correct but it sometimes needs elaboration. Similarly, there are instances where it is well to record that a certain diagnosis has been considered but finally replaced by an opinion that the appearance is normal. An example of this might be where a film artefact is found simulating a fracture line. Recording of this opinion may forestall a feeling that the diagnosis has been missed. Then too there are examinations with normal findings in which it may be advisable to answer a specific question in the requisition to show that it has not been overlooked.

The practise of including in the interpretation an account of the projections used is deplored, more particularly if there is an established routine for the area. It is suggested that this information, along with other technical and procedural data, should be placed in a section away from the interpretation where it may be referred to if desired. The clinician is primarily concerned with what has been found — not with intimate details of the method of discovery. Omission of reference to projections might eventually bring an end to the undesirable practise of the referring physician specifying how the radiologist should do his work. This is perhaps contentious ground, but it is annoying to receive a request for unwarranted projections from a physician who is repeating a patter, perhaps with a show of knowledge. To surrender the privilege of determining the best projections for a particular radiological problem is to equate radiology with a drug store snapshot photo developing business. That some of this privilege has been lost can only be blamed on ourselves.

There is no need to put down on paper the justification for each diagnosis with a play-by-play account of the turbulent mental processes involved in arriving at a final diagnosis. It is sufficient that the radiologist be prepared to defend his diagnosis if and when questions are asked. Common findings call for a minimum of discussion unless assigned to a rare cause, in which case one may record justification for the diagnosis. The aim for brevity should not prevent one from listing

the diagnoses considered, if it is apparent that the conclusions are only weakly supported. Most diagnoses are made from a knowledge of the relative frequency of a particular change seen. We offer our opinions with one eye on statistics. This is as it should be. Few roentgen changes are absolutely diagnostic, but to list all the possible causes for every departure from normal would be unhelpful.

The report should be tailored somewhat to the referring physician. Terminology clear to the specialist may be unintelligible to others. A referring physician who has infrequent contacts with the X-ray department may welcome information pointing out specifically the area covered, the limitations in the inferences to be drawn and suggestions for other examinations that would be helpful.

There is no need to pretend omniscience in the interpretation of radiographs. In the desire to be helpful, one must subdue a tendency to record a guess at the pathology in situations where a more frank statement would be that the answer is not known. On the other hand, if the answer is thought to be known, it may be well in appropriate cases to acquaint the referring doctor with some idea of the positiveness with which the opinion is held, so that he may have some reservations about the diagnosis. Failure to do this may deprive the patient of desirable further investigation.

One has to be careful lest the satisfaction of finding one lesion stops the search for others. There is a natural tendency to deal with the situation at hand which frequently blots out thought of additional mischief in remote areas. At the conclusion of each report one might benefit from consideration of the familiar notice on hotel room doors: "Stop. Have you forgotten something?"

One should also take care, in wording the report, to spare the feelings of the referring doctor if his diagnosis is shown to be incorrect. An unhappy choice of words, interpreted as suggesting that he blundered, will surely lead to requisitions lacking any clinical information. It is desirable to keep the radiological examination on the plane of a friendly consultation, with each member giving his opinions and findings freely.

In these days of a growing litigation-conscious public, one should avoid expressions of opinion that could be wrongly taken to imply lack of good medical care. For example, one should avoid the use of the word "unsatisfactory" in reporting on the position of bone fragments. This is particularly true where the radiologist is not aware of the circumstances under which reduction was made. A position unsatisfactory for one patient may, for medical reasons, be perfectly acceptable for another. It is preferable to report actual measurements of shortening and degrees of angulation, and to leave it to the surgeon to decide if the position is satisfactory. This does not prevent one from giving a verbal opinion as well, if asked.

An almost universal complaint in our branch of medicine is that of failure of communication to the radiologist of the pertinent facts of the patient's history and clinical findings. Proper interpretation depends so much upon these that it is a matter of speculation as to why this should be so. Some of the fault undoubtedly lies in the tiring pace of modern medicine in which the filling of documents makes excessive demands upon one's time. Another cause may be in the fear of embarrassment for wrong clinical judgments. A third cause may be in the thought that bias in interpretation may be introduced. However it is likely that the effect of bias, if it exists at all, is eliminated by the radiologist's satisfaction in making an independent diagnosis. Further, surely no radiologist is so dishonest in his thinking that he will make a diagnosis merely to please the clinician. One answer to the problem of getting information may lie in the wording of our radiological reports. Where applicable, one should acknowledge the fact that the information given has provided the helpful clues to the meaning of the radiographic appearance — evidence, as it were, in building up a case.

To conclude, one should attempt to make the radiological report informative, brief, honest and lucid. In essence, the report should reflect the spirit of the radiological profession; it should show an earnest desire to help the patient regain his health.

Summary

A plan for interpretation of radiographs is presented with a suggestion for an orderly procedure to be followed. Brevity is favoured. Technical and procedural data might preferably be placed in a section apart from interpretation. The clinician is primarily concerned with what has been found. Terminology may have to be changed to suit the referring physician; wording that is clear to the specialist may be unintelligible to others. Care should be taken to avoid expressions that might wrongly be taken to imply lack of good medical care.

Résumé

L'auteur expose un plan d'interprétation des radiographies en suggérant de suivre une analyse méthodique. Il favorise un texte court. Il serait aussi préférable d'insérer les données techniques de l'examen indépendamment de l'interprétation. Le clinicien s'intéresse de

prime abord à ce qui a été découvert. La terminologie doit parfois s'adapter au genre de médecin consultant. La phraséologie d'un rapport peut être claire pour le spécialiste mais incompréhensible pour un autre médecin. On doit éviter avec soin les expressions qui prêteraient à mauvaise interprétation quant à la qualité des soins médicaux.

REFERENCES

1. Garland, L. H., Studies on the Accuracy of Diagnostic Procedures. Am. J. Roentgenol. & Rad. Therapy, 82, 25-38, 1959.

BOOK REVIEWS

A Radiographic Index, M. Goldman, R. S. Miller, D. Cope, 77 pp., John Uright & Son, Ltd. The MacMillan Company of Canada Limited, Toronto, 1961. $2.30.

This pocketbook has been designed to provide technicians with a large amount of radiographic information in a concise and orderly manner. Although this book is not a detailed standard text of radiography, it does fill a definite need of some graduate radiographers and all students.

The radiographic examinations are listed alphabetically, thus affording rapid reference to any specific topic. Adequate cross-indexing is included so that most synonyms are available. With many examinations there is a preliminary statement which explains very briefly the purpose of the procedure. This is followed by an itemized list of the various positions, with a description of each. Illustrations are not included, as this would add greatly to the size of the book and thereby defeat one of its main purposes. When indicated, a brief description concerning the preparation of the patient is included. Exposure tables are given in an appendix to the main text. Random tests using these exposure factors indicate that they produce roentgenograms of good diagnostic quality. With these factors as a base-line, a technician should be able to procure good films, if using unfamiliar diagnostic X-ray equipment.

There are also appendices listing contrast media, a glossary of medical terms and abbreviations. Unfortunately the contrast media are ones that are commonly in use in England and many of them are unfamiliar to Canadian radiographers. This same criticism applies to some abbreviations. The glossary of medical terms should be helpful to technicians, medical secretaries and receptionists in radiological offices.

This book is a welcome addition to the literature on radiographic technology and should be recognized as a simple reference pocketbook for the radiographer.

G.I.N.

Radiographic Anatomy of the Human Skeleton, W. H. Johnson, F.S.R., J. A. Kennedy, M.B., M.R.C.S., D.M.R., D.M.R.D., E. & S. Livingston Ltd., Edinburgh and London, Published by The MacMillan Co. of Canada Ltd., 1961. $8.50.

The book is designed primarily as an anatomy text for the student radiographer and secondly as a quick reference for the experienced radiographers, as well as an authorative guide for the general practitioner.

Radiological anatomy has been approached in this book in a new and refreshing manner. British authors have long had a reputation of being both lucid and concise and this book proves to be no exception.

The complete osseous structure of the human skeleton is encompassed by superbly reproduced radiographs with accompanying diagramatic illustrations. The technique of proper positioning, while not extensive, is sufficient. Discussion of bony development, though of interest to a technician, is not a prerequisite for capable radiography, and is kept to a minimum. Terminology is in particular to be commended as being up-to-date in popular words and phrases commonly used in the field of radiology; proper and out-moded terms are often found in parentheses accompanying the radiographs and diagrams. The written descriptions of bone function, articulation and supportative joint structures are most readable and clear. The necessity for the strength of the cranium, the importance of the thoracic cage in respect to the interior anatomy, and the pelvic structures, are described in understandable terms. In basic radiography of the osseous ske'eton there is not a serious omission for a teaching and reference text of this kind.

This book well earns its place among the texts and manuals now used by students of radiographic technique, and is further recommended for review and reference of bony anatomy to the practitioner, technician and radiologist.

G.I.N.

POSITIONS AVAILABLE